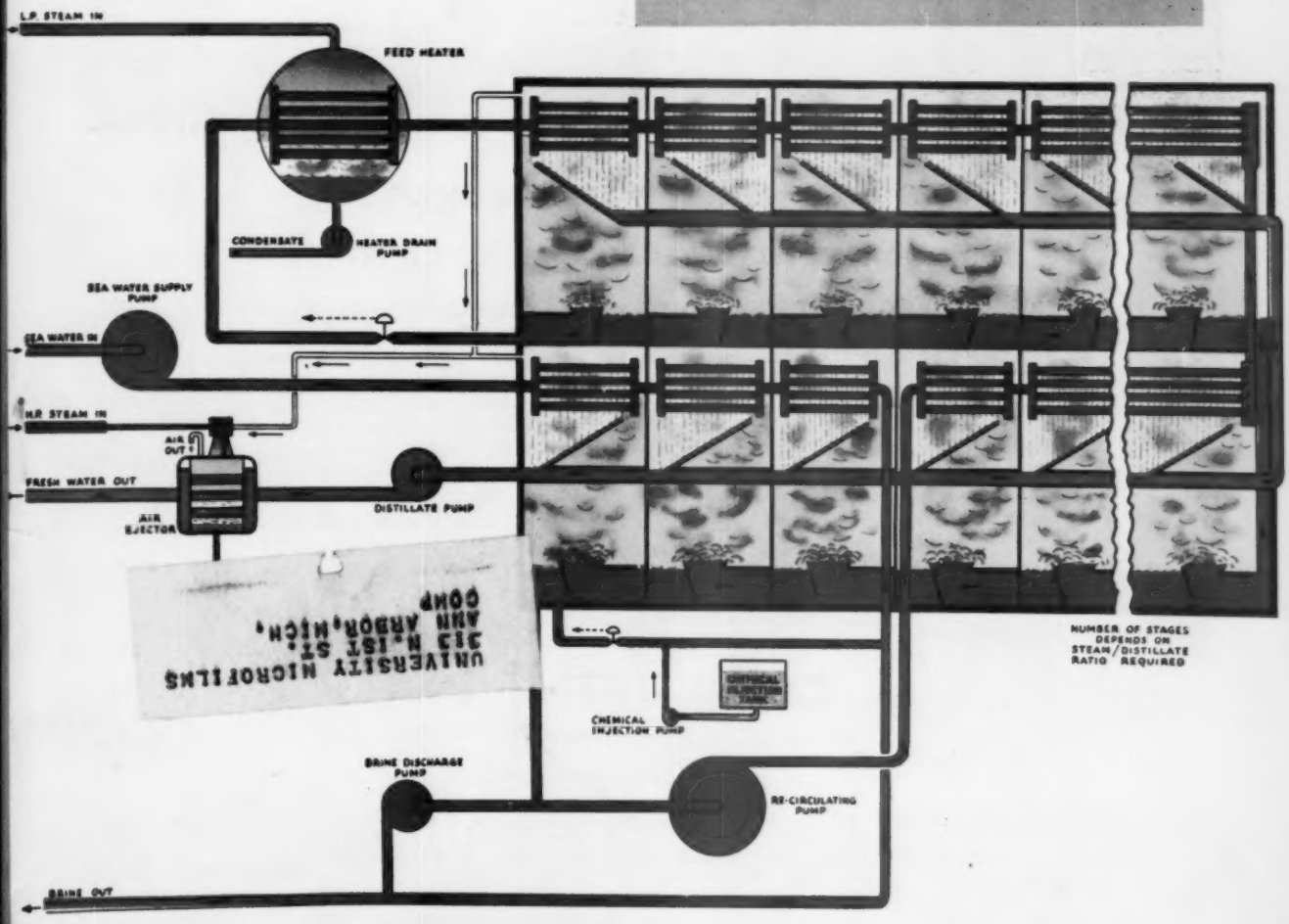
A Scranton Gillette Publication

NOVEMBER 1960

WATER & SEWAGE WORKS

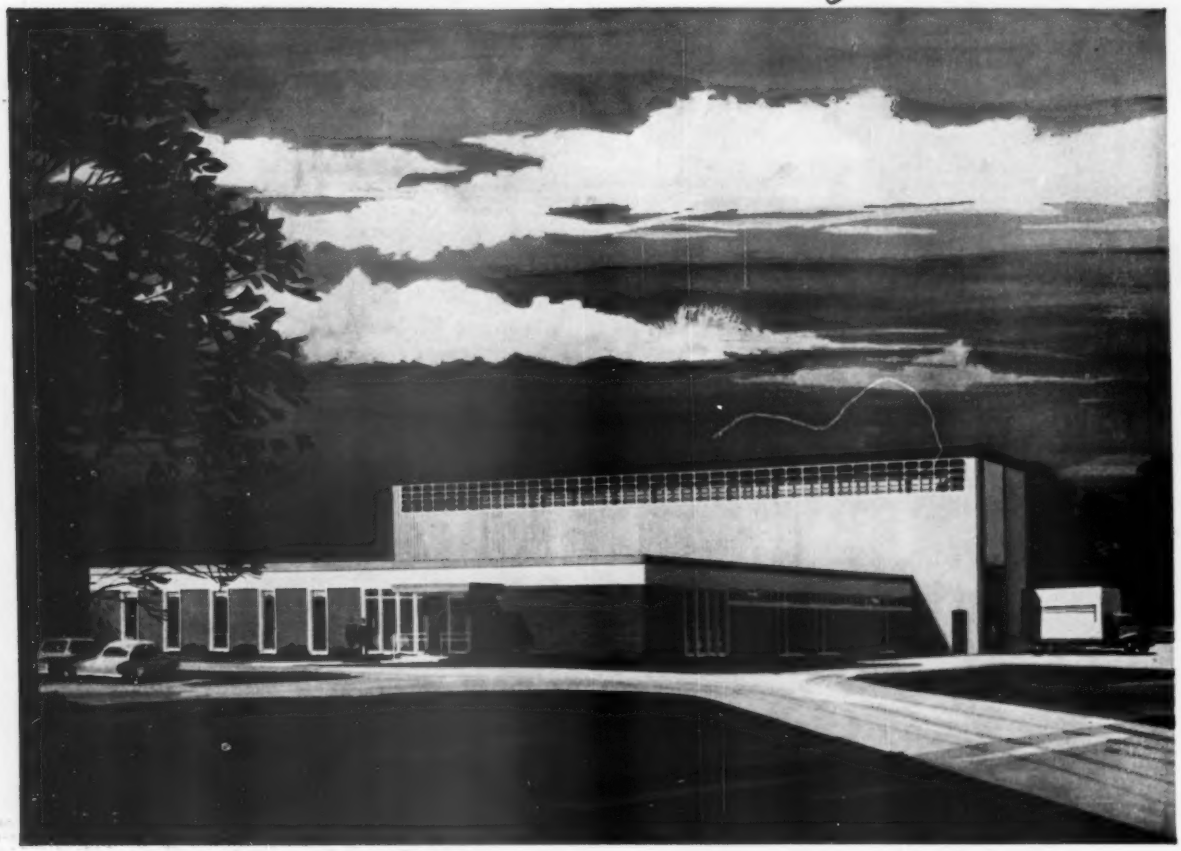
WATER SUPPLY • SEWAGE DISPOSAL

MULTIFLASH DISTILLATION OF SEA WATER
Simplified operation diagram; for full details see pg. 413



UNIVERSITY MICROFILMS
313 N. 1ST ST.
ANN ARBOR, MICH.

LOCK JOINT PIPE COMPANY *Proudly Presents*



ITS *New*, LARGER AND IMPROVED

RESEARCH AND DEVELOPMENT CENTER

Although Lock Joint Pipe Company has maintained its own research and testing laboratory for many years, the Company's growth and insistence on even higher quality products and improved manufacturing techniques have demanded the expansion of these facilities. For this reason it has erected a new research center featuring the latest equipment and staffed with scientists, engineers and trained technicians.

The members of the Research and Development Division, housed in this new half-million dollar center, stand guardian over the high quality of all present Lock Joint products and institute and evaluate future product developments. For it is the Company's firm conviction that only by strict quality control can its products' superiority be maintained . . . and that only through the development of even better materials and more efficient manufacturing techniques can Lock Joint retain its position at the head of its field.

LOCK JOINT

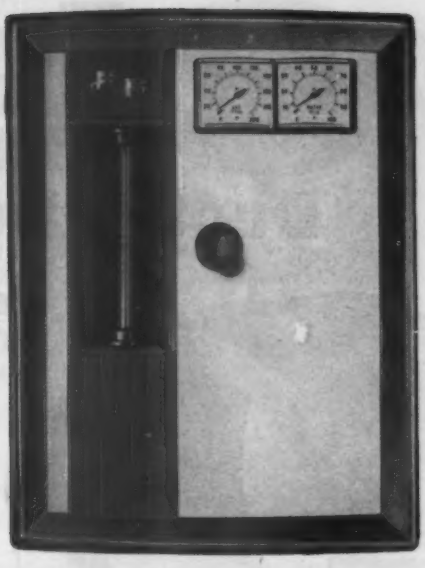
CONCRETE PIPE

LOCK JOINT PIPE CO.

East Orange, New Jersey

Sales Offices: Chicago, Ill. • Columbia, S. C. • Denver, Col. • Detroit, Mich. • Hartford, Conn. • Kansas City, Kan. • Perryman, Md. • St. Paul, Minn. • Winter Park, Fla.

Pressure • Water • Sewer • REINFORCED CONCRETE PIPE • Culvert • Subaqueous



This, believe it or not, is a wall mounted chlorinator. Its attractive appearance is our way of showing how proud we are of the advanced operating parts hidden behind the front panel. For example: This is the first wall mounted chlorinator ever to feature a single stack regulator. Simple, compact appearance belies the fact that it can handle up to 200 pounds per day of chlorine more accurately, dependably, and safely than any other chlorinator with the single exception of its big brothers. It is so completely corrosion-proof in the right places that we have little hope of ever selling replacement units. In short, we have never been happier with any product than we are with the new Series 3600 chlorinators.

Should you wish to order one of these beauties sight-unseen, on our say-so, we can deliver immediately from warehouse stocks across the country. If not, your local F&P field office will gladly demonstrate the 3600 Series at your plant, at your convenience. Call for an appointment. Or, write for complete information in Bulletin 70C3600. Fischer & Porter Company, 210 Fischer Road, Warminster, Pa.

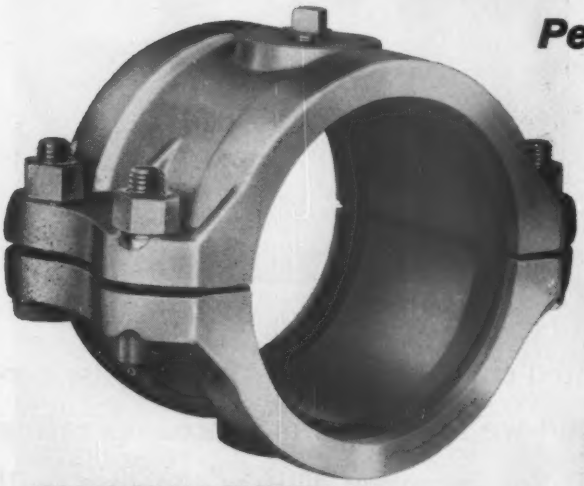
FP

FISCHER & PORTER COMPANY

INSTRUMENTATION AND CHLORINATION

These MANUFACTURING AFFILIATES carry Fischer & Porter engineering designs to the far corners of the earth: FISCHER & PORTER (CANADA) LTD., DOWNSVIEW, ONTARIO • FISCHER & PORTER LTD., WORKINGTON CUMBERLAND, ENGLAND • FISCHER & PORTER G.m.b.H., GROSSELLERSHAUSEN, BEI GOTTINGEN, GERMANY • FISCHER & PORTER N.V., KOMEETWEG 11, THE HAGUE, NETHERLANDS • FISCHER & PORTER Pty. LTD., 184 HANNA ST., SOUTH MELBOURNE, VICTORIA, AUSTRALIA.

NEW CLOW
Ductile Iron Split Sleeve



Permits easier, quicker, permanent repair of 4", 6" & 8" transverse cast iron pipe underground breaks

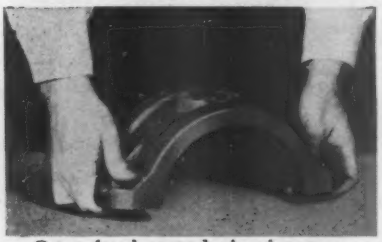
LIGHT WEIGHT Assembled 4" diameter sleeve weighs but 26 lbs. Weight of 6" sleeve is 32 lbs., 38 lbs. for 8" sleeve.

SHORT LENGTH Effective length of 4 inches between end seals on all sizes. Overall length is 6¼".

TWO-PIECE ASSEMBLY No end glands. Side and end gaskets are pre-assembled and cemented in sleeve grooves.

HIGH STRENGTH All parts are high tensile and corrosion-resistant. Sleeve halves are 70,000 psi tensile ductile iron. Nuts and bolts are high strength, corrosion-resistant alloy.

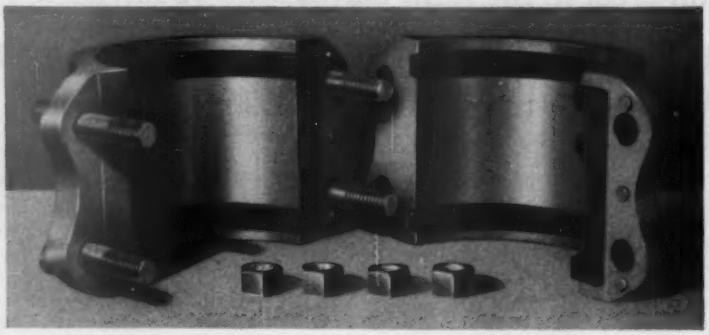
ASSEMBLED IN 3 EASY STEPS



Once the damaged pipe is uncovered, one half of the sleeve is placed on each side of the pipe.

Sleeve halves are drawn together. Pre-assembled rubber gaskets make tight seal.

After the bolts are taken up finger-tight, tightening the four bolts by wrench completes assembly.



HERE'S ALL THERE IS TO IT! Illustration shows two-piece glandless construction. Side gaskets overlap ends of circumferential gaskets for tight seal. Four bolts are only accessories. Tapping boss on each half allows maximum tap of 2 inches. Regularly furnished with one sleeve-half tapped for ¾" pipe.

JAMES B. CLOW & SONS, INC.

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Eddy Valve Company, Waterford, New York
Iowa Valve Company, Oskaloosa, Iowa

Vol. 107 No. 11
NOVEMBER • 1960

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E. SCRANTON GILLETTE
Publisher

V. W. LANGWORTHY
Editor

C. F. GURNHAM
Consulting Editor

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Contributing Editors

D. P. Buckmeyer — R. E. McKinney
J. R. Baylis — R. C. Merz
P. D. Haney — A. M. Rawn
C. E. Keefer — R. W. Simpson
J. F. Dye — W. A. Carley

•

CHICAGO OFFICE: 185 N. Wabash Ave.
E. S. Gillette, Publisher
H. J. Conway, Adv. Ed.
V. W. Langworthy, Editor
W. W. Hamilton, Western Sales Mgr.
M. C. Barr, Circulation Mgr.
R. J. Rooney, Makeup Editor
E. J. Hoeffer, Asst. Editor
M. McGinnis, Edit. Secy.

•

NEW YORK OFFICE: 155 East 44th St.
T. M. Todres, Administrative Assistant
Wm. R. Joyce, Midwestern Sales Mgr.
Terence McCoy, Eastern Sales Mgr.

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1901 West 8th St., Los Angeles 5, California
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Two 150 hp Ideal Squirrel Cage Induction Hollow Shaft Vertical Motors at City of Detroit's new Spring Wells Pumping Station

Three 400 hp Ideal Wound Rotor Induction Solid Shaft Vertical Motors in another area at Spring Wells Pumping Station

the proof is in the PUMPING

Yes, whether installed in a chemical plant in Kentucky, in a sewage plant in Ohio, or on an irrigation project in Arizona, the proof of IDEAL Vertical Motor performance and economy is in the hundreds of successful pumping installations across the nation.

With the complete line of IDEAL Vertical Motors, there is no *second* best! The REASON? You select the proper motor type with enclosures, insulation, bearings, couplings and mounting base to meet your exact requirements *without compromise!* And whatever you expect from a Vertical motor, you are sure of *more* with IDEAL Verticals — on any application.

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Bulletin 219 — 150 H.P. and up.

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Meetings

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1960

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Nov. 13-16—Fort Lauderdale, Fla. (*Galt Ocean Mile Hotel*) FLA. SECTION A.W.W.A. Secy., John G. Simmons, Plant Supt., Water Dept., West Palm Beach

Nov. 13-16—Fort Lauderdale, Fla. (*Galt Ocean Mile Hotel*) FLA. SECTION WATER POLLUTION CONTROL FEDERATION

Nov. 16-17—Indianapolis, Ind. (*Hotel Washington*) IND. SECTION WATER POLLUTION CONTROL FEDERATION

Nov. 28-30—Pullman, Washington (*Washington State University*) CONFERENCE ON WATER QUALITY IN COLUMBIA RIVER BASIN. Write W. H. Knight, Tech. Ext. Services, Washington State University, Pullman, Washington

Dec. 12-14—Washington, D.C. (*Sheraton-Park Hotel*) NATIONAL CONFERENCE ON WATER POLLUTION. Contact Frank A. Butrico, Exec. Secy., National Conference on Water Pollution, Public Health Service, U.S. Dept. of Health, Education, and Welfare, Washington 25, D.C.

Jan. 31-Feb. 1—Urbana, Ill. (*Univ. of Ill.*) THIRD SANITARY ENGINEERING CONFERENCE. Write Ben. B. Ewing, Assoc. Prof. of Sanitary Engineering, University of Illinois, Urbana, Ill.

Feb. 1-3—Indianapolis, Ind. (*Sheraton-Lincoln Hotel*) IND. SECTION A.W.W.A. Secy., Chester H. Canham, State Board of Health, 1330 W. Virginia St., Indianapolis

Mar. 16—Boston, Mass. (*Statler-Hilton Hotel*) NEW ENGLAND SECTION A.W.W.A. Secy., Ralph M. Soule, San. Engr., State Dept. of Public Health, Boston, Mass.

Mar. 22-24—Chicago, Ill. (*LaSalle Hotel*) ILL. SECTION A.W.W.A. Secy., Dewey W. Johnson, Research Engr., Cast Iron Pipe Research Assn., 3440 Prudential Plaza, Chicago 1.

ALLIS-CHALMERS

One of the compact groups of A-C rubber-seated butterfly valves at the pumping station of a southwestern municipality.

The right valve "repeats itself"

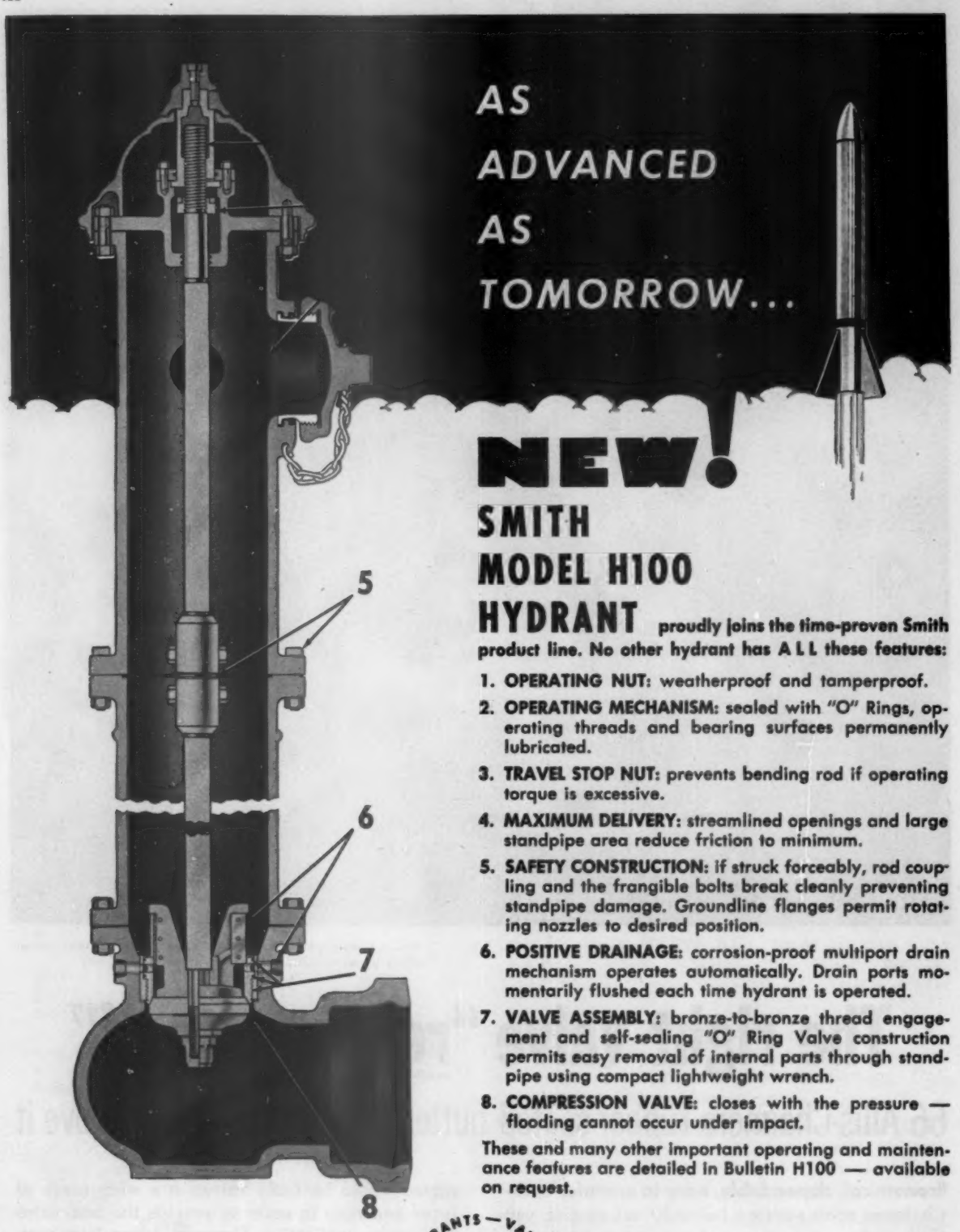
66 Allis-Chalmers rubber-seated butterfly valves line up to prove it

Economical, dependable, easy to operate: Allis-Chalmers rubber-seated butterfly valves give you these and so many more advantages that it's easy to appreciate their universal popularity. Full body protection is provided by a rubber seat which extends through the valve body and over the flange faces. Angle seating protects the rubber seat and permits seating adjustment without costly disassembly.

A-C manufactures a complete line of metal and rubber-seated butterfly valves in a wide range of types and sizes in order to provide the best valve for a given application. Compact design joins with light weight to bring other savings in both space and cost of construction.

• • •

For details on butterfly valves, cone valves and ball valves, contact your A-C representative or write **Allis-Chalmers,** *Hydraulic Division, York, Pa.* A-1309



NEW!

SMITH MODEL H100 HYDRANT

proudly joins the time-proven Smith product line. No other hydrant has ALL these features:

1. **OPERATING NUT:** weatherproof and tamperproof.
2. **OPERATING MECHANISM:** sealed with "O" Rings, operating threads and bearing surfaces permanently lubricated.
3. **TRAVEL STOP NUT:** prevents bending rod if operating torque is excessive.
4. **MAXIMUM DELIVERY:** streamlined openings and large standpipe area reduce friction to minimum.
5. **SAFETY CONSTRUCTION:** if struck forceably, rod coupling and the frangible bolts break cleanly preventing standpipe damage. Groundline flanges permit rotating nozzles to desired position.
6. **POSITIVE DRAINAGE:** corrosion-proof multiport drain mechanism operates automatically. Drain ports momentarily flushed each time hydrant is operated.
7. **VALVE ASSEMBLY:** bronze-to-bronze thread engagement and self-sealing "O" Ring Valve construction permits easy removal of internal parts through standpipe using compact lightweight wrench.
8. **COMPRESSION VALVE:** closes with the pressure — flooding cannot occur under impact.

These and many other important operating and maintenance feafures are detailed in Bulletin H100 — available on request.

HYDRANTS — VALVES

THE A.P. SMITH MFG CO.

SINCE 1896

EAST ORANGE NEW JERSEY

"I screamed for pump service and they send me a salesman!"

"40-dozen housewives . . . the mayor . . . and every important business man in town on my back and the manufacturer sends out a *salesman* to fix my pump. That beats anything I ever heard . . . expecting a salesman to double as a serviceman . . . I need a man who knows pumps and *fixes pumps* for a living. I need him bad . . . RIGHT NOW!"

Trained service . . . one of the many inherent qualities you are given when you buy Allis-Chalmers. Industrial Equipment Division, ***Allis-Chalmers,*** *Milwaukee 1, Wisconsin.* A-1243

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At Allis-Chalmers, the servicemen "service" and the salesmen sell. Every regional office has available a network of specifically factory-trained men to service pumps "on the spot." Certified Service Shops can rebuild equipment quickly . . . save you transportation expense and time. When you call for service, you get service . . . from servicemen. The quickest and best offered by any pump manufacturer.

Briefs

Multiflash Distillation of Sea Water describes this process by which potable water is obtained from the sea—Page 413.

Determination of the Flow Parameters of Sludge explains the basis from which work with fluids of this type is derived and presents a formula for application to sludge flow in pipes—Page 417.

Measurement of Large Flows in Open Channels—An article that supplements one published in 1944 by considering Parshall flumes of which the dimensions have been extended to a throat width of 50 feet—Page 422.

Design and Operation of Sewage Lift Stations—The three basic types of stations, wet pit, dry pit and pneumatic-ejector, are reviewed and their suitability for specific jobs discussed—Page 425.

Shenango Valley Water Company Expands Its Plant to assure its continuous record of never having to restrict water useage—Page 427.

Remote Hand Control of Valves in Pipelines is a long desired means of emergency handling of plant valves. This article discusses some of the available materials and methods of operation—Page 430.

Water Quality and Instrumentation begins a report on the Cincinnati Symposium sponsored by the U. S. Public Health Service. The role, use and instrumentation of water quality data was discussed.

My Galoshes—Partially oriented runs amuck . . . with his boots on—Page 438.

Some Applications of Elementary Solution Equilibrium Chemistry—The essentials of this phase of water chemistry are presented for the benefit of both engineers and plant operators—Page 439.

Hypochlorination of Wastes is the third in a series dealing with hypochlorite materials and use. In particular, the applications for treating sanitary and industrial wastes are discussed—Page 443.

Urban Redevelopment and Thermal Discharge—Among the important matters discussed at the Pa. Section AWWA Meeting were the water problems created by urban renewal and by thermal discharges into water supplies—Page 448.

Magnetic Flowmeter Fills the Bill for a New Jersey Community allowing it to be a good neighbor and kill two problems with one instrument—Page 452.

News

Great Lakes Basin Gets Anti-Pollution Study

Surgeon General Leroy E. Burney today announced the start of a six-year anti-pollution study of the United States jurisdiction of the Great Lakes Basin-Illinois waterway.

Under a $500,000 appropriation by the Congress, the Public Health Service's Division of Water Supply and Pollution Control will direct immediate attention to:

1. An inventory of all points of inflow into the Chicago River, Sanitary and Ship Canal, the Calumet-Sag Canal, and their tributaries;
2. Measurement and analysis of municipal and industrial wastes being discharged at such points of inflow;
3. Effect of such discharges on water quality of the Illinois Waterway under present rate of flow;
4. Methods of improving water quality of the Illinois Waterway;
5. Determination of water quality of the Illinois Waterway under present and various decreased rates of flow.

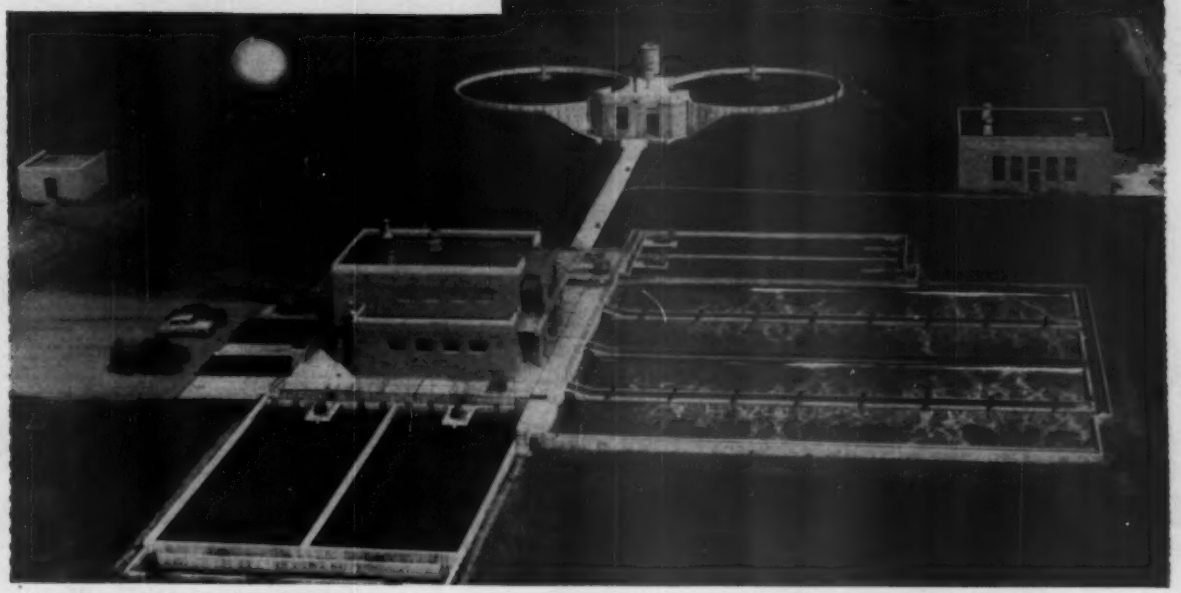
The study is designed to aid development of a comprehensive plan to control and prevent pollution in the area.

The recent appropriation of $500,000 covers the first year of the project. The funds will be used to start intensive studies of the kinds and amounts of municipal and industrial wastes being discharged into the waterways within the metropolitan area of Chicago, and the pollutional effects of these wastes in the waterways in Chicago. Laboratory facilities and staff are being organized to conduct the project. A 40-man staff of engineers, chemists, biologists, and other scientists and technicians is being assembled.

Project headquarters will be in Chicago, under the direction of the Public Health Services Division of Water Supply and Pollution Control. William Q. Kehr, Public Health Service Engineer, is Project Director. The overall project is being coordinated by H. W. Poston, Water Program Director of the Regional Office of the Public Health Service in Chicago.

P.F.T.

DUAL DIGESTION



Modern Sewage Treatment at Connersville.

Embodying the following features, the Connersville, Indiana Sewage Treatment plant is serving the community efficiently and economically—

P.F.T. Dual Digestion. Not only do the two 65′ P.F.T. Floating Cover Digesters receive the normal domestic wastes, but in addition, they receive garbage collected weekly from residential areas. This highly volatile waste, after a grinding process, is pumped directly to the P.F.T. digesters.

Compactness. The Control Building is located in the center of the aeration and settling tanks and simplifies the control of plant operations. Expansion of the plant will be possible without disrupting operation because of this structural arrangement.

Equipment. Besides the two 65′ P.F.T. Floating Covers, Connersville also has a #750 P.F.T. Heater and Heat Exchanger Unit, and P.F.T. Gas Safety Equipment.

Engineering. Garns and Moore and Associates, Inc., Indianapolis were the Consulting Engineers.

P.F.T.

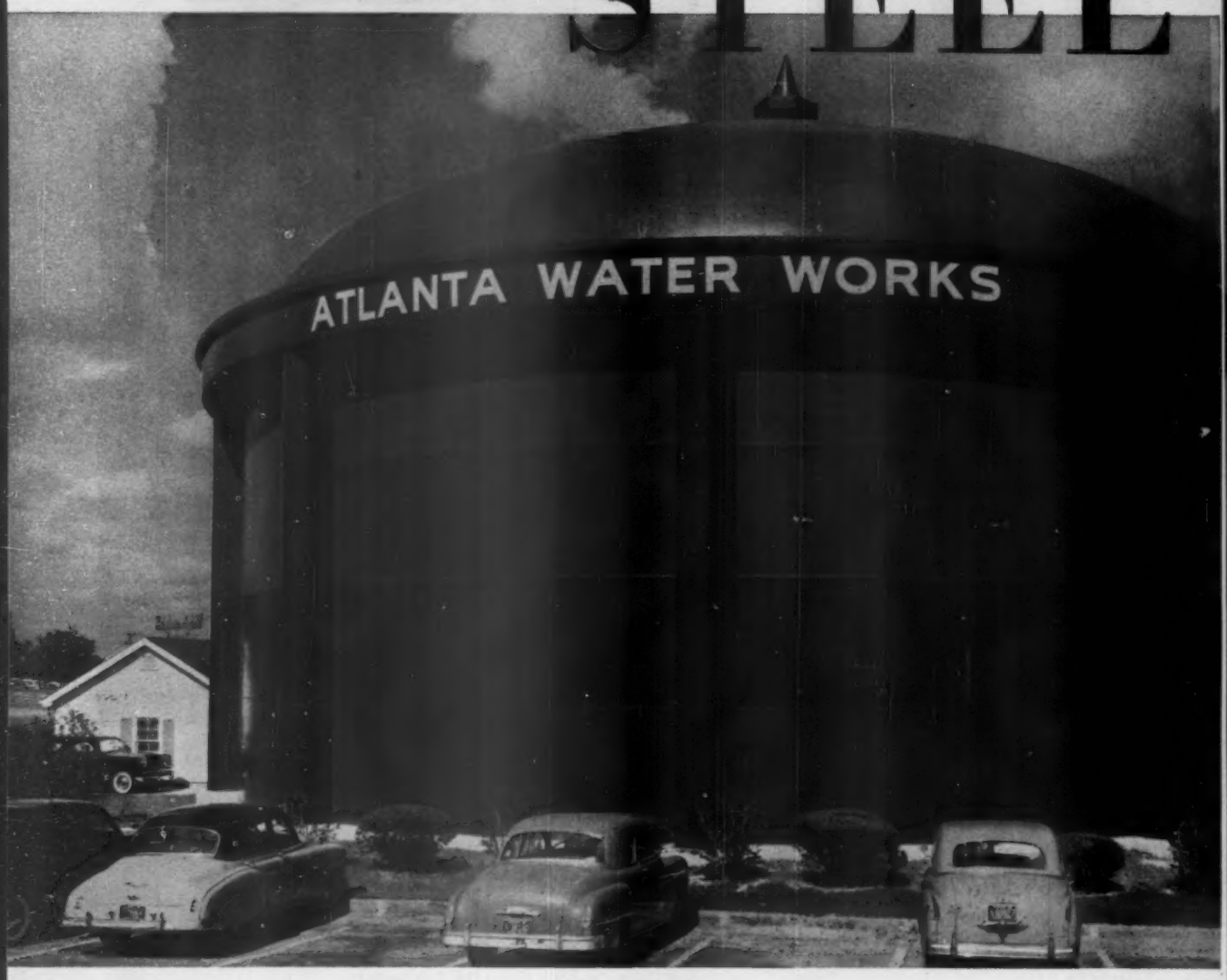
waste treatment equipment exclusively since 1893

PACIFIC FLUSH TANK CO.

4241 RAVENSWOOD AVENUE, CHICAGO 13, ILLINOIS

PORT CHESTER, N.Y. • SAN MATEO, CALIF. • CHARLOTTE, N.C. • JACKSONVILLE • DENVER

THE STRENGTH OF STEEL



CB&I-built structures store 15,000,000 gallons

Providing first class water service to a city which triples in land area, through annexation, is not easy—but it can be done. The Atlanta, Georgia, Water Works did it with *two* remarkably engineered building programs, carried on simultaneously.

Atlanta kept its sleeves rolled up for five years to meet the two-way challenge: (1) expansion of the distribution system and (2) capital improvements to the existing system.

Two 2,000,000-gallon CB&I-built radial cone-bottom tanks were erected first to overcome the most pressing problem: *low pressure during periods of peak consumption.* Later, three CB&I-built ornamental reservoirs rose as milestones in the ambitious, fast-moving program. Upon completion of the program, CB&I-built structures were providing Atlanta with 15,000,000 gallons of storage.

Today, these steel reservoirs are proud landmarks of Atlanta's municipal achievement. Pleasing in appearance, durable and "bottle-tight", they offer sound testimony as to why *more water is stored in steel* than any other type of material.

Write your nearest CB&I office for the bulletin: *CB&I Standpipes and Reservoirs.*

M56CB

Chicago Bridge & Iron Company

WATERSPHERES® • WATERSPHEROIDS® • ELLIPSOIDAL BOTTOM TANKS • RADIAL-CONES • SPHEROIDALS • STANDPIPES • RESERVOIRS • HORTONSPHERES® FOR GAS SERVICE

LANDMARKS $75,000,000 WATER SYSTEM

2,000,000-gallon ornamental wash water reservoir is 94 ft. in diameter. A CB&I-built 4,000,000-gallon reservoir also serves the Atlanta Water Works.

One of two CB&I 2,000,000-gallon radial cone tanks which help Atlantans save more than $1,000,000 in annual insurance premiums.

Above: This 5,000,000-gallon CB&I-built reservoir was described as "big enough to accommodate 1,000 automobiles."

Atlanta • Birmingham • Boston • Chicago • Cleveland • Detroit • Houston • Kansas City (Mo.) • New Orleans
New York • Philadelphia • Pittsburgh • Salt Lake City • San Francisco • Seattle • South Pasadena • Tulsa
Plants in: BIRMINGHAM • CHICAGO • SALT LAKE CITY • GREENVILLE, PA. • NEW CASTLE, DELAWARE
In Canada: HORTON STEEL WORKS LTD., TORONTO, ONTARIO

News—Here & There

National Conference on Water Pollution

Surgeon General Leroy E. Burney has sent invitations to more than 300 selected National groups and organizations asking them to send representatives to the first National Conference on Water Pollution, sponsored by the Government. The meeting will be held at the Sheraton-Park Hotel in Washington, D. C., December 12-14.

More than 1,000 persons are expected to participate in the Conference. They will include representatives of local, state, interstate and Federal agencies; representatives of agriculture, industry and labor; leaders in the fields of environmental health and sanitary engineering; members of civic, conservation, and women's clubs and organizations; and those individuals who have concerned themselves with this problem or who are associated with the fields of water technology.

The three-day program of the Conference has scheduled a first day devoted to plenary sessions, a second day to four concurrent panel and floor discussions, and a third day to further floor discussion and a summarization.

One of the Conference's features will be a banquet held Monday evening. Those attending will be addressed by a panel of four Congressional members prominently identified with water resources and management. The panel will represent both Houses of Congress and both political parties.

Speaking in behalf of the Senate will be Robert S. Kerr of Oklahoma and Francis Case of South Dakota; speaking for the House will be John Blatnik of Minnesota and William Cramer of Florida.

The program also lists four panel discussions which are intended to help develop and clarify the theme of the Conference, "Clean Water—A Challenge to the Nation."

Panel I—Water Pollution and our Changing Times: *Effects of Pollution on the National Health, Welfare and Economy.*

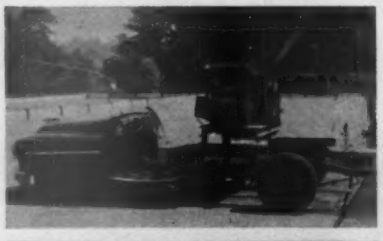
Panel II—Meeting the Growing Competition for Water: *Pollution Control as a means of Increasing Available Water Supplies.*

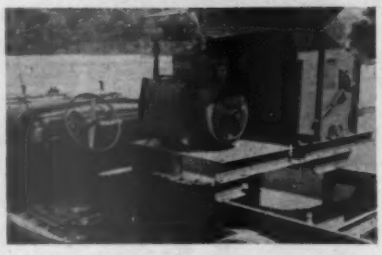
Panel III—Keeping Water Clean: *Responsibilities of Government, Industry, and the Public.*

Panel IV—Research and Training: *Critical Needs for Research, Resources, and Training.*

Sludge Grinder Converted from Old Car

Anthony (Tony) Schopf, an operator at the Pleasant Hills (Pa.) Authority Sewage Treatment Plant, has provided the "latest", though not the most conventional, equipment innovation in sludge disposal. Using a 1955 Mercury as a basic unit, Tony designed and built a mobile sludge grinder by ripping out the aft part of the car and installing a motor, grinder and hopper in its place.





So mobile and versatile is the machine that he can easily back it into a full bed of sludge and do all the grinding on the spot. Although the Plant is noted for its up-to-datedness both in regard to equipment and operating procedures, it is most noted for being just about the most beautiful plant of its or any kind in the country.

The question is, however, whether the plant's personnel are prouder of it orthodox technology or its "way-out" disposer of bedded sludge.

On TV "Troubled Water"

The American Broadcasting Company is preparing a one-hour documentary on Water Pollution which will be televised Tuesday, January 23, 1961, as part of the Bell and Howell series. John Charles Daly will be the narrator; he has long been concerned with water problems and is currently an appointed member of the President's Water Pollution Control Advisory Board.

The emphasis of this documentary will be the individual's responsibility in correcting the "troubled water" of the Nation. Municipal and industrial problems, will be discussed sympathetically but firmly. Public health is, of course, the primary goal.

This broadcast will be a "must" for all persons interested in the problem of water pollution. We suggest that our readers check with their local stations NOW to insure that it will be available for local release.

Industrial Water & Wastes Is The New Name For *Industrial Wastes*

Our sister publication, formerly entitled "Industrial Wastes", has undergone a change in title, cover, and content with its October issue.

INDUSTRIAL WATER & WASTES is the new name, and as indicated therein, the editorial policy has been broadened to include problems of procurement, treatment, and conservation of industrial water, as well as those of liquid wastes, air pollution, and solids disposal.

However, INDUSTRIAL WATER & WASTES will deal solely with industrial problems, thus preventing duplication of municipal problems currently covered by WATER & SEWAGE WORKS.

We realize that some problems will be of interest to both fields, and in these cases we shall endeavor to bring such information to the attention of both fields.

What Every WATER SUPERINTENDENT Should Know About

AMERICAN METERS

All Bronze

FROST BOTTOM METER

Now, a true frost bottom meter of all bronze construction . . . internal metal parts, meter body, frost bottom. There are no dissimilar metals exposed to the water.

When the ALL-BRONZE frost-bottom American Meter freezes, the center section breaks by tension immediately relieving the strain on all internal parts. The exact location and type of fracture are design controlled. Every American Frost-Bottom Meter breaks in the **same** manner, at the **same** pressure, at the **same** place.

All interior parts including the gears move with the ice and are undamaged. After a freeze-up, only the bottom must be replaced — a low-cost, simple operation.

The All-Bronze Frost Bottom feature is one of many outstanding, cost-saving features of American Meters all described in Bulletin 58. We will be glad to mail you a copy on request.

BUFFALO METER COMPANY
INCORPORATED
2909 Main Street **Buffalo 14, New York**

News—Here & There

CONTINUED FROM PAGE 12A

Boruff Named to U.S. Water Control Board

Dr. Clair S. Boruff, Technical Director of Hiram Walker and Sons, Inc., has been named by President Eisenhower to a three year term as a member of the Federal Water Pollution Control Advisory Board.

The Board makes recommendations to the Surgeon General of the U.S. Public Health Service on matters relating to the Federal water pollution control program. Dr. Boruff attended his first Advisory Board meeting in San Francisco recently when members surveyed the water resource and water pollution problems of the Bay area.

Since 1928, when he became chemist (later chief research chemist) of the Illinois State Water Survey, Dr. Boruff has been engaged in water, waste, fermentation and related research. In 1934, he became Research Director, then Technical Director of the Hiram Walker Company in Peoria, Ill., where he has also served as chairman of the Water Resources Committee of the Peoria Association of Commerce and the Illinois State Chamber of Commerce.

In 1957, he was appointed industry's representative on the Illinois State Sanitary Water Board. In addition, he has been the distilling industry's representative on the National Task Committee on Industrial Wastes since that organization was founded in 1950; he was its chairman in 1953.

Book Review

Exception has been taken to the familiar concept that no more and no less water is available on our planet now than was present shortly after creation. In his book, *New Water For a Thirsty World**, Michael Salzman calls on water works men everywhere to examine more closely the potential juvenile water supply which may be available deep in the earth. Bound up in geologically historical crevices, a supply of magnetic water may be available for the locating and taking. This new water would supplement meteorological water, U.S. consumption of which will about equal the usable supply toward the end of this century.

The 1896 thesis of A. E. Nordenskiold about production of new water from non-meteorologic sources and the present day work of Stephen Riess in locating water in deep fissures are used as a basis for Mr. Salzman's call for research. He states (p. 35) that "It would certainly appear reasonable today that research expenditures in the tens of millions of dollars would be more than justified if thereby these heretofore 'unavailable' waters could be produced and made available at economic cost." Considerable effort is exerted in the book toward explaining how magnetic cooling results in the precipitation of solid materials, leaving water usable if and when drawn to the surface. There are some who disagree as to usability of water derived from these sources, saying that there is good chance of excessive solids concentration.

Reading this book carefully leaves one with a thought that is generated by the first paragraph of Chapter One. In speaking of an invitation to meet Stephen Riess, the author goes on: "Several weeks before this invitation a national magazine had run an article raising the question "Does He Get Water From Rock?" (*Colliers,* February 4, 1955). A faculty member of another university had reacted to this article by publicly labelling this man lucky, a charlatan, a witch and a fake. But his description of the man had excited my curiosity."

It isn't so much what Mr. Salzman says in his book that excites curiosity about Mr. Riess, as what he does not say. In his attempt to point out the requirements for studying the possibilities of supplementing our known water resources with primary water, he uses Mr. Riess' successes as an example of what can be done. What the author doesn't do, and thereby leaves the reader hanging, is tabulate the *failures* along with what are the better of his successes. As a result, it is impossible to satisfy the curiosity generated at the outset. And a well-written Foreward by Aldous Huxley doesn't help either.

* *New Water For a Thirsty World*, by Michael Salzman, Science Foundation Press, Los Angeles, California, 181 p., (1960), $5.95.

Wanted—Sanitary Engineers

Competitive examinations for appointment of sanitary engineers as officers in the regular Corps of the Public Health Service will be held January 31 through February 2, 1961, for Junior Assistant applicants and January 31 through February 3, 1961, for Assistant and Senior Assistant applicants.

The examinations will be given at a number of places throughout the United States, and applications must be in the office of the Surgeon General, U. S. Public Health Service, Washington 25, D. C., no later than December 2, 1960.

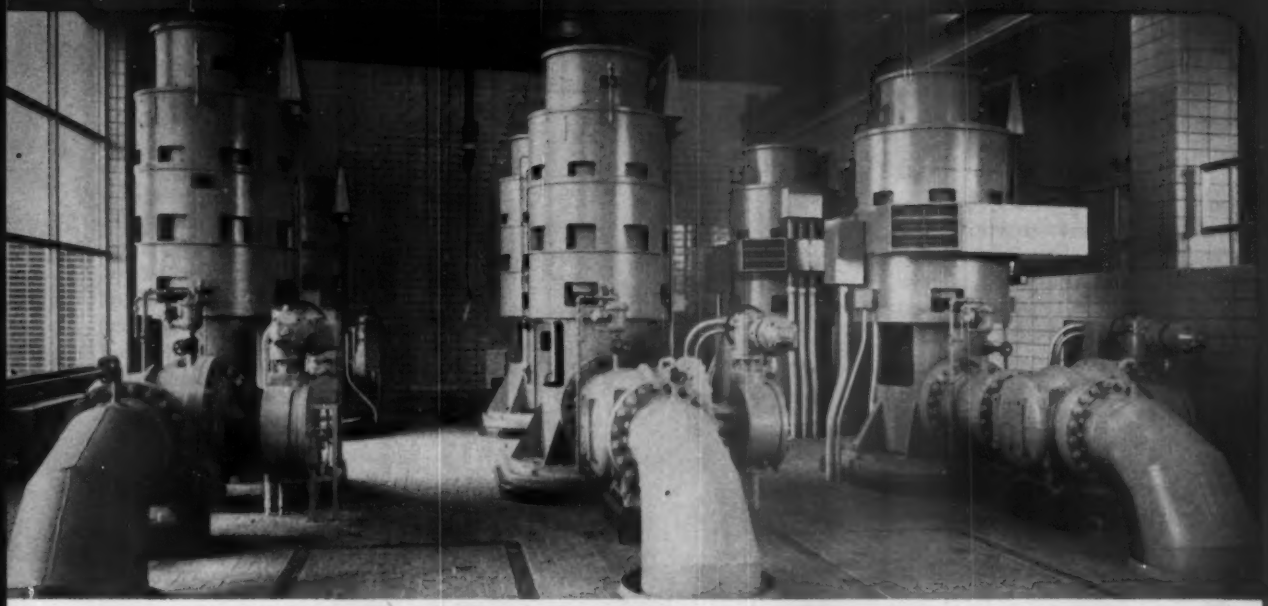
The assignments available to sanitary engineers are:

Environment Health: The sanitary engineering activities of the Service offer a variety of assignments that include both the recognized and established sanitary engineering function in water supply and treatment, sewage and waste treatment and disposal, water pollution control, interstate carrier sanitation, and the new fields of air pollution and radiological health.

Research: The Robert A. Taft Sanitary Engineering Center at Cincinnati, Ohio, conducts research in almost every aspect of environmental health. The Communicable Disease Center, with headquarters in Atlanta, Ga., and field stations throughout the U. S., utilizes engineers in many research and teaching positions in disease and vector control activities involving research, consultation and demonstration.

A Correction

It has been brought to our attention that an inadvertent error appeared in the Potomac River Filtration Plant story of our September issue. On page 357, a sentence indicates that a 30 in. ball valve manufactured by Allis-Chalmers was installed in the venturi chamber of the 48 in. service line. We recently have learned that the manufacturer of this valve was the Valve Division of the Willamette Iron and Steel Company. Several rotary type valves manufactured by Allis-Chalmers were used in this project.



PLENTY OF WATER for Springfield-66 MILLION GPD Max.

Springfield, Ohio has a completely new, automatic water supply system by Layne. It guarantees 66 million gallons per day for their present and future needs—a job complete by Layne—and a completely satisfied customer. Field Tests exceeded the guaranteed pump efficiencies by 1% to 2% on all units. Consulting Engineers: Black and Veatch, Kansas City Missouri. Water Supply Contractors: The Layne Ohio Company, Columbus, Ohio. Do you need complete water service? Get it from Layne. Write for Bulletin 100.

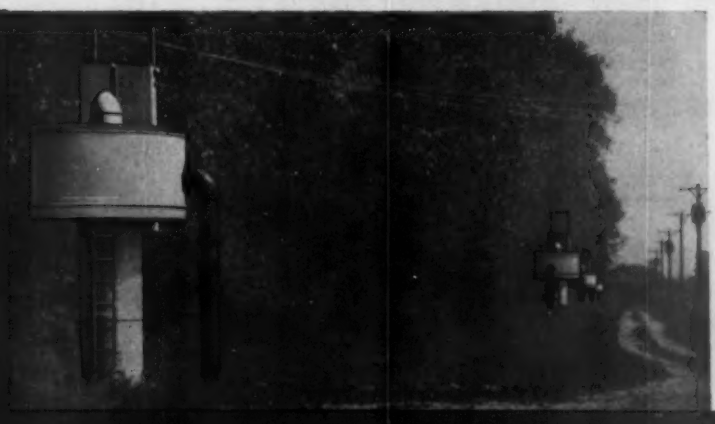
Specifications

RAW WATER—10 Layne Gravel Wall Wells with Layne 18-8 Stainless Steel shutter screen and 10 Layne deep well pumps. 2800 GPM — 65 ft. TDH, 75 hp—440 Volts— 1750 RPM, located in two banks pumping to the filter beds. Pumps were installed 15 feet above ground level for flood protection.

FILTERED WATER—Six Layne high service pumps boosting filtered water into distribution system. Five are 12 MGD-285 ft. TDH, 700 hp—4160 volts—1185 RPM. Two are variable speed units. The sixth Layne Pump is a 6 MGD-285 ft. TDH, 400 hp—4160 volts —1185 RPM. All pumps operate through the central control panel.

City of Springfield, Ohio

LAYNE OFFERS COMPLETE WATER SERVICE: Initial Surveys • explorations • recommendations • site selection foundation and soil-sampling • well drilling • well casing and screen • pump design, manufacture and installation construction of water systems • maintenance and service • chemical treatment of water wells • water treatment—all backed by Layne Research. *Layne services do not replace, but coordinate with the services of consulting, plant and city engineers.*



Layne SINCE 1882 — WORLD'S LARGEST WATER DEVELOPERS

LAYNE & BOWLER, INC., MEMPHIS

GENERAL OFFICES AND FACTORY, MEMPHIS 8, TENN.

LAYNE ASSOCIATE COMPANIES THROUGHOUT THE WORLD

Sales Representatives in Major Cities

Equipment News

American Well Expands Rental Equipment Division

1103

American Well Works, Aurora, Ill., announces that its entire line of pumps, water purification and sewage treatment equipment is now available through its expanded Rental Division.

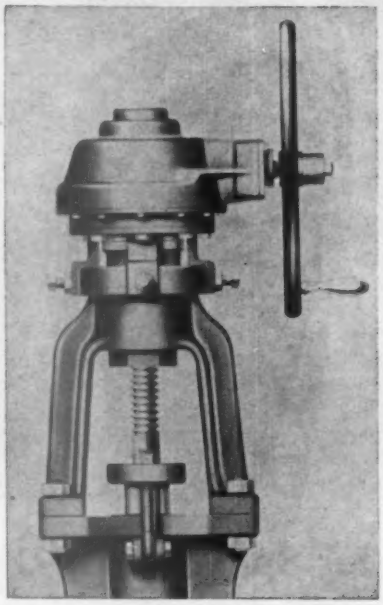
Included in the plan are the newly introduced Oxy-Pak total oxidation package sewage treatment plants for smaller industries and communities.

With pumping, water, and pollution problems multiplying for cities and industries, American-Well Company hopes that this enlarged division will help many situations where initial capital investment is proving the stumbling block.

"Converto-Gear Operator" for Valves

1104

Crane Co., Chicago, Ill., has announced the availability of a new bevel gear operator officially called the "Converto-Gear Operator".



This actuator is designed to provide power-assist in opening and closing iron and steel O.S. & Y. and non-rising stem gate valves having stem diameters of 2½ inches or less. Of major significance is the fact that the "Concerto-Gear Operator" can be supplied with new valves, or ordered separately and installed in the field on present Crane valves.

The operator uses a bevel gear with a 4.11 to 1 ratio, and the unit is adaptable for either pneumatic or electric power wrench operation. To add the "Converto-Gear Operator" to O.S. & Y. valves with ball bearing yokes: (1) remove handwheel, (2) slip on yoke sleeve adapter, (3) position operator adapter and mark for countersinking four holes in yoke, and (4) bolt the operator to the adapter. To convert non-rising stem valves: (1) remove handwheel, gland and stuffing box. (2) install the bonnet adapter, (3) insert stem adapter, and (4) position and bolt the operator.

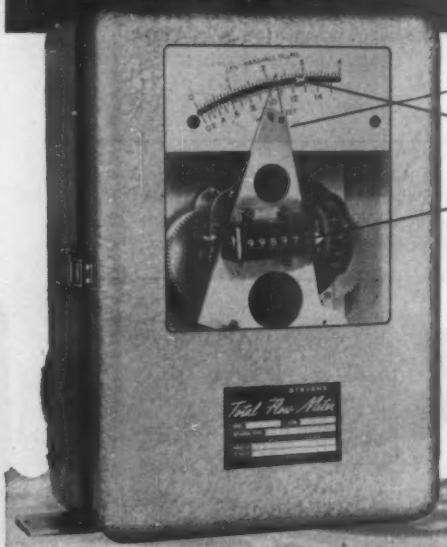
"Nema-Matched" Pumps

1105

Fairbanks, Morse and Co., Kansas City, Kan., is introducing its new line of "Adapt-Able" centrifugal pumps, designed to furnish a wider range of clear water, non-clog and other liquid modifications. Featured

CONTINUED ON PAGE 21A

STEVENS
TOTAL FLOW METER
Model 60M



Low-cost meter provides essential flow data for operation of sewage treatment plants

- **INDICATES FLOW**—Rate of flow and head are indicated by pointer and scale.
- **INDICATES PEAK FLOW**—Sliding red index on scale indicates peak flow.
- **TOTALIZES VOLUME**—Counter totalizer registers total flow.

Mechanically operated meter provides essential data in measurement of sewage, industrial wastes, irrigation water or other liquids flowing in open channels. Standard meter gives direct flow reading in cu. ft./sec. and totalizes volume in cu. ft. Readings are easily converted to other units of measurement.

The instrument is designed for use with Parshall flumes and various weirs. It is entirely mechanically operated, will function without attention for eight-day intervals, and is easy to install on table, shelf or wall. If a graphic record is desired, the meter can be used with a Stevens Type F Recorder. Write for Stevens Hydrologic Instrument Short Form Catalog No. 23, and for Bulletin 28 which describes the Model 60M meter in detail.

HYDROGRAPHIC DATA BOOK—Valuable reference file, 124 pages of technical data on recorder installations, plus a wealth of hydraulic tables and conversion tables. $1 copy. (No C.O.D.'s)

LEUPOLD & STEVENS INSTRUMENTS, INC.
4445 N. E. Glisan Street, Portland 13, Oregon
Specialists in hydrologic instruments for over a half a century

"from Chicago"

The NEW

FLUSH KLEEN® System

TWO MAJOR DESIGN IMPROVEMENTS

1. NEW FLO-THRU STRAINER
... permits greater solids loading

2. NEW BY-PASS FITTINGS

(including special By-Pass Valve and *separate* By-Pass inlet line to wet well)

... allow greater inflow capacity

... permit pump selection based only on *discharge capacity*

PROVIDES THESE ADVANTAGES

- Lower original costs ... smaller pumps and motors required
- Pumps handle clear liquid only
- Absolute reliability—pumps cannot clog
- Reduced maintenance
- 100% standby capacity
- Longer pump life

NEW... Successfully handles high wet-strength paper products

NEW... Successfully handles ground garbage

NEW... Increases maximum solids loading capacity

NEW... Uses smaller pumps a. 1 motors

OVER 13,000 FLUSH KLEEN® INSTALLATIONS FOR:

Municipalities • Industrial and Commercial Buildings • Schools • Institutions • Hotels • Hospitals • Motels • Auditoriums • Subdivisions • Ships

Write for Bulletin No. 122-D

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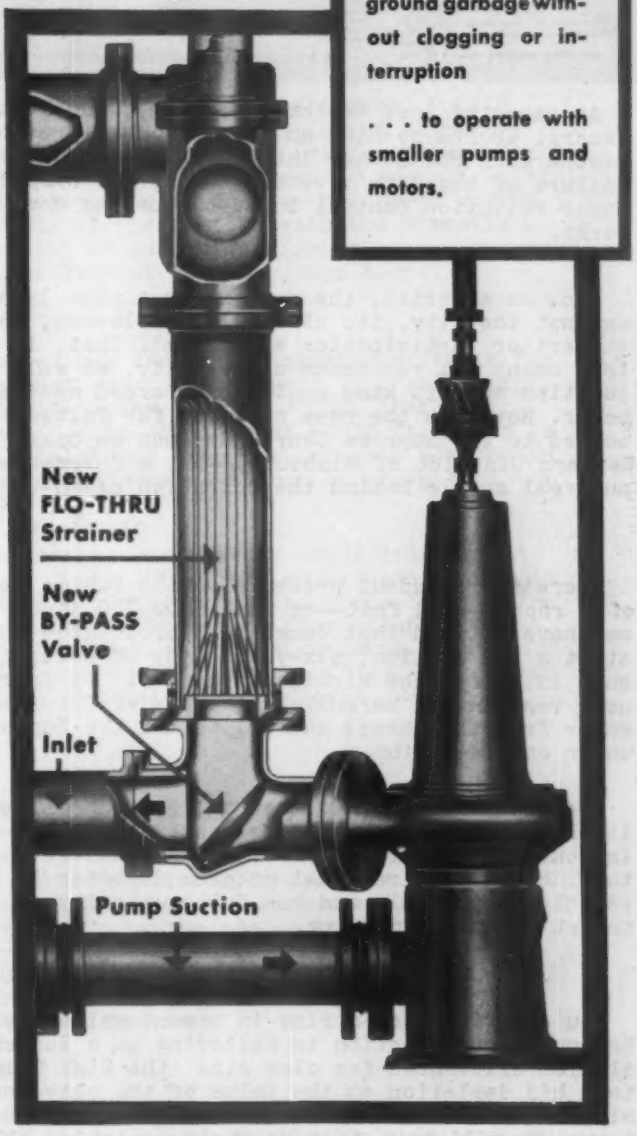
COMPLETELY REDESIGNED

... to handle modern high solids loadings of wet-strength paper products and ground garbage without clogging or interruption

... to operate with smaller pumps and motors.



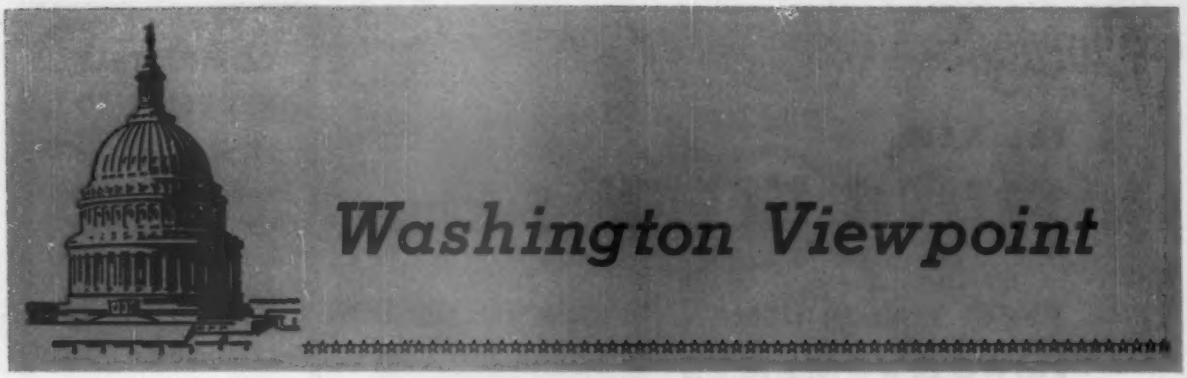
SOLIDS NEVER REACH THE IMPELLER

Putting Ideas to Work

FOOD MACHINERY AND CHEMICAL CORPORATION
HYDRODYNAMICS DIVISION

CHICAGO PUMP

622H DIVERSEY PARKWAY • CHICAGO 14, ILLINOIS



As expected (see September column), the Department of Justice has filed suit in Federal courts seeking an injunction to prevent the City of St. Joseph, Mo., from discharging raw sewage into the Missouri River. The action, as you know, follows failure of the City's voters to approve compliance with orders from the Federal Water Pollution Control Board by turning down a bond issue to finance disposal works.

And, as expected, the suit poses a nice legal problem: It seeks an injunction against the City, its officials, employees, and "any and all persons in active concert or participation with them". That, in the opinion of lawyers in Washington, means all residents of the City, as well as the officials. Just how an injunction of this kind could be enforced against some 78,000 persons is a real poser. How soon the case comes up for initial trial (and it will certainly be appealed to the Supreme Court) depends on Court dockets (U.S. District Court for Western District of Missouri)—but a favorable decision for the Government would put real muscle behind the pollution clean-up drive.

☆ ☆ ☆ ☆

There's tremendous pressure on the Public Health Service to get out some kind of a report—and fast—on that $500,000 study of pollution in Lake Michigan. You may have noticed that Congress appropriated the money (as part of HEW funds) to start a $12 million, six-year study of pollution in the Great Lakes. But the pressure is on for the Michigan study: (1) to form a basis for legislative action next year on the perennial attempts of Chicago's Sanitary District to divert more water from the Lakes; and (2) to aid the Supreme Court, which also has this matter under consideration.

The implication, in comments from Congressional committee members, is that Public Health had best get some answers quickly—or the rest of the program may be in some doubt. Working fast, PHS has delegated full responsibility for the work to W. H. Poston, regional program director at Chicago. He's building a staff as rapidly as possible and has full authority to negotiate with consultants and others to get the program going.

☆ ☆ ☆ ☆

You can figure on a rise in cement prices next year as a result of the Internal Revenue Service action in following up a Supreme Court decision concerning depletion allowances for clay pipe (the High Court decided the manufacturer must take his depletion on the value of the clay—not on the value of the finished pipe). On cement, IRS said that under a new amendment to tax laws, cement manufacturers will have to take their depletion allowance at "kiln-feed" (the point at which calcium carbonates and silicas are fed into the kiln), rather than on the finished cement. Net result is certain to be a price rise—particularly in view of a bad year in 1960 (earnings-wise, anyway) for cement makers.

☆ ☆ ☆ ☆

It is certain that major changes in the status and work of the Federal pollution control effort will come up for serious consideration when Congress gets back to work next January. You may know that there are at least two plans now under consideration: one proposed by the present Administration; the other by Congress-

man John A. Blatnik, who was the author of the original bill making Federal grants for pollution control work. So it is obvious that something will be up, next time, regardless of the outcome of the election. The Administration has proposed placing the existing divisions of water, air, radiation and industrial hygiene under a new Bureau of Environmental Health, to report directly to the Surgeon General. Blatnik wants to establish a Federal Water Pollution Control Administration as an independent agency—taking it out of the Health, Education and Welfare Department entirely.

At bottom of this agitation for change is a basic disagreement over whether pollution is a medical or an engineering problem. Blatnik argues that it is an engineering one, having to do with conserving natural resources. The Eisenhower administration, so far at least, seems to prefer keeping a doctor (the Surgeon General in this case) in command.

☆ ☆ ☆ ☆

With the increasing use of the Great Lakes by ocean-going shipping, Public Health Service has issued quarantine notices prohibiting dumping of shipboard sewage near water intakes of some 150 communities along the Lake's shores. With two exceptions—vessels in distress, or those providing sewage or waste treatment approved by the Surgeon General—all vessels are forbidden to discharge wastes of any kind within a circle having a radius of three miles with the domestic water intake as the center. (A complete list of quarantined areas, including nautical coordinates, has been printed in the Federal Register,page 8925.)

☆ ☆ ☆ ☆

The Atomic Energy Commission has proposed new design and packing criteria for radioactive waste disposal to insure against loss of integrity to great depths. The criteria—which became effective in mid-October—require that containers "retain their integrity" until they reach depths of at least 6,000 ft, which is the disposal level required by new AEC regulations. The new criteria also authorize sea disposal of waste metals without containers if it can be shown that the metal will sink to a depth of about 6,000 ft.

Bookshelf item: The Bureau of Reclamation has published a new edition of its "Earth Manual", succeeding the edition of June, 1951. Written by specialists in the field of soil mechanics, the booklet provides current technical information in the field of laboratory investigations of soils used as foundations and materials for dams, canals and other types of water control structures. You can can get a copy (for $3.75) from the U.S. Government Printing Office, Washington 25, D.C.; or BuRec's offices in the Denver Federal Center, Denver, Colo., attention 841.

☆ ☆ ☆ ☆

New regulations controlling heights of structures that may be built or altered near airports,or heliports (or on airways) will be of major interest to waterworks engineers. The regulation is issued by the Federal Aviation Agency (Part 626, Notice of Construction or Alteration)and specifically refers to water tanks, smokestacks, buildings of any kind, that might present a hazard to safe air navigation. Mathematical criteria for determining the proper height of such structures are given; procedures are specified for hearings on proposed structures, and there is an appeals procedure outlined. Structures several thousand feet away from the ends of runways, for instance, will be affected, as well as many in cities where heliports may be established.

☆ ☆ ☆ ☆

Washington itself was getting worried about the City's principal source of domestic water (the Potomac River above Little Falls), particularly in view of reports from various regional planning groups that single the river out as the major future water sources for a rapidly expanding metropolitan area. But Army Engineer reports for the year which ended June 30 found a rapid increase in coliform bacteria—an increase so great, they said, that the river is now more polluted than at any time in 10 years. The coliform count was 6787 per 100 milliliter sample, compared to 4862 in 1959, and 2429 in 1958. Reasons advanced were the fact of a very rainy summer which may have washed fertilizers and vegetable matter into the stream in greater than usual quantities, plus the dumping of sewage—some of it only partially treated—into the stream by Virginia and Maryland communities.

NEW!
MUELLER®
COPPER METER YOKE
. . . for tight corner settings!

■ This new copper yoke now lets you set the meter in basement or utility room corners where the piping is too close to the walls to install regular yokes. Meters can be properly set at a convenient height for easy reading and servicing. The sturdy design rigidly supports the house piping and protects the meter from piping stresses.

Installation is fast, too! Convenient union connections for installing yoke in steel pipe or compression couplings for installing in new or existing copper pipe. No other fittings are needed.

Compression couplings with locking nut positively insure continuous electrical bonding of the piping.

two models available:

for 5/8" x 3/4" meters:

- for ¾" steel pipe
  H-14811 — Copper Meter Yoke with ¾" inside I.P. thread union connections on inlet and outlet.
- for ¾" copper pipe
  H-14815 — Copper Meter Yoke with compression couplings (regular or locking nut type) on inlet and outlet.

Write for complete information.

MUELLER CO.
DECATUR, ILL.

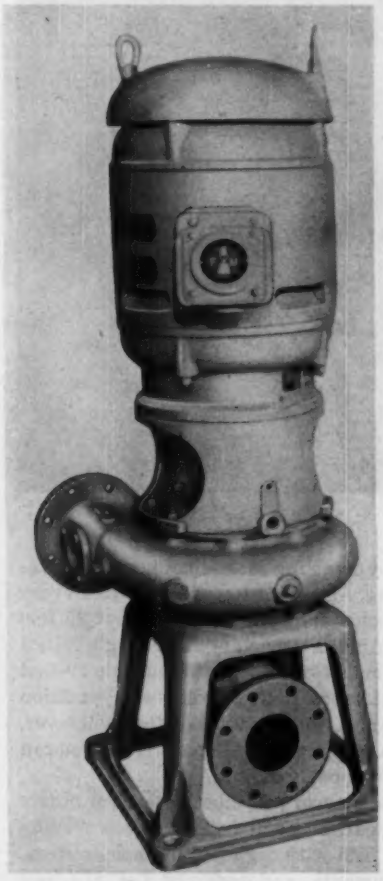
Factories at: Decatur, Chattanooga, Los Angeles;
In Canada: Mueller, Limited, Sarnia, Ontario

4410

Equipment News

CONTINUED FROM PAGE 16A

innovation of this new line is the fact that each pump is NEMA-matched; that is, the pump dimensions align with those of NEMA-rated motors for ease of mounting and trouble-free operation. The Adapt-Ables are constructed so that the pump frames receive various size volutes and impellers. Thus, each individual pump becomes, in effect, the equivalent of several individual units.



Besides their versatility, the new units offer other exclusive advantages: the standardization with NEMA motor frame dimensions allows installation without makeshift height-adjusting blocks and odd-bore couplings; maintenance and conversion are made more quickly, easily, on-the-spot; the need for parts inventories is reduced, since even the bearings of pump and motor are interchangeable.

These pumps are available in both conventionally-mounted horizontal and vertical pump and motor units, as well as the F-M "biltogether" construction. Both horizontal and vertical units feature cartridge-type mechanical seals or conventional stuffing boxes, with easy factory or field changeover to suit pumping requirements. The vertical pumps are constructed so that stuffing boxes can be repacked, bearings adjusted or rotating elements removed without disturbing inlet and outlet pipes, regardless of whether the pipes contain sewage, industrial wastes or solids in slurry.

Free Discharge Valves for Large Water Uses

1106

Allis-Chalmers Manufacturing Co., Milwaukee, Wis., announces the expansion of its free discharge valve line with the introduction of a new, low head, Howell-Bunger valve for

CONTINUED ON PAGE 23A

Millipore announces a New Laboratory Manual for Bacteriological Water Analysis

Particular emphasis is placed on manipulative details in the enumeration of coliform organisms.

Specific techniques are included to isolate plankton algae and determine suspended solids.

The Millipore Procedure for the control of potable waters has been approved as a standard method by:

The American Public Health Association

United States Public Health Service

American Water Works Association

Federation of Sewage and Industrial Wastes Associations

National Research Council of the National Academy of Sciences

Millipore FILTER CORPORATION
Dept. WS, Bedford, Massachusetts

Send me a free copy of the Millipore Manual for Bacteriological Water Analysis.

Name:.....

Title:.....

Professional Address:.....

City:.....Zone.....State.....

My principal field of interest is:.....

.....

providing totalization
of varied flows from
30 GPM
to
1,500,000 GPM

Direct totalization and accuracy with negligible head loss are outstanding features of all Sparling Main-line meters.

More than 30,000 Sparling Main-line meter installations are serving American towns and cities every day, with thousands more in use throughout 29 foreign countries. Applications vary from single 2-inch meters for minimal requirements to multiple 19-foot installations that handle flows in excess of 1½ million gallons per minute... universal proof that wherever, or whatever, the need for Main-line metering you can specify, and depend on, Sparling.

Sparling is the pioneer propeller meter. For nearly half a century Sparling equipment has been serving the waterworks field with high performance meters, recording instruments, and controls. Let Sparling serve you, too. *Write for Catalog #315, or call your local Sparling field engineer.*

SPARLING
WATER CONTROL EQUIPMENT

HERSEY-SPARLING
METER COMPANY
Sparling Equipment: **EL MONTE, CALIF.**
225 North Temple City Blvd.

Branches: Atlanta · Chicago · Cleveland · Dallas · Denver · Kansas City, Mo. · Roselle, N. J. · San Francisco · Seattle • United Kingdom Affiliate: TYLORS OF LONDON LTD.

Equipment News

CONTINUED FROM PAGE 21A

use under 200 ft head. Available in sizes from 12 inches to 108 inches by 6 inch increments, the new valve is of lighter construction than the heavy-duty Howell-Bunger valve designed for heads up to 400 ft.

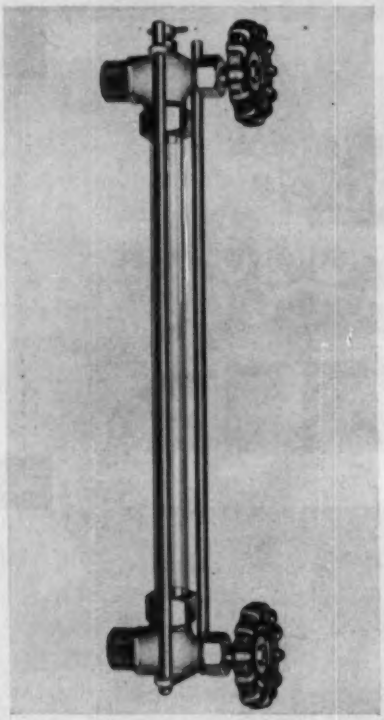
This low head, fabricated steel plate valve has two operating gears on a shaft through the valve body, instead of three, arranged around the outside as on the heavy duty models.

The valve is a throttling arrangement which operates from full open to full closed to permit water to be discharged to atmosphere from behind a dam, usually from a position on the outer face at the base. It is being used in water works, hydraulic plants, and for irrigation and floor control.

Bronze Water Gauges

1107

Crane Co., Chicago, Ill., has introduced three new bronze water



gauges, two in ½ inch sizes and one in ¾ inch size. Fourteen-inch centers are provided on the ½ inch sizes, and an 18 inch center on the ¾ inch size.

One of the ½ inch gauges, No. 627, incorporates a more streamlined and compact body than that of previous models. It also has a smaller and more efficient drain cock.

The other two gauges, No. 630 in ½ and ¾ inch sizes, have the following new features: (1) identical ⅝ inch O. D. glass; (2) identical packing nut, packing material for the glass; (3) a new, smaller and more efficient drain cock.

Single Plate Sewage Digester Floating Cover

1108

Infilco, Inc., Los Angeles, Calif., is offering a new type of sewage digester floating cover, composed of rectangular steel plates field-welded into a single deck without trusses, to which a protected insulation is directly applied.

Designed by Wiggins, and available by exclusive arrangement of Infilco and General American Transportation Corporation, the "Mono-

CONTINUED ON PAGE 29A

W&T COMPOUND-LOOP CONTROL

By residual analysis and information feedback, Wallace & Tiernan Compound-loop Control adjusts chlorinator feed rates to changing water flows and chlorine demands. You can add W&T Remote Residual Recording and Controlling Components throughout your water system and centralize control at any desired location. You select the desired residual on a central panel and the Compound-loop System maintains that residual faithfully.

Remote recording by W&T gives you duplicate residual records and minute-to-minute information where it helps guide operation. Remote controlling by W&T lets you adjust a chlorinator miles away. And W&T Remote Components adapt to almost any system, any type of control.

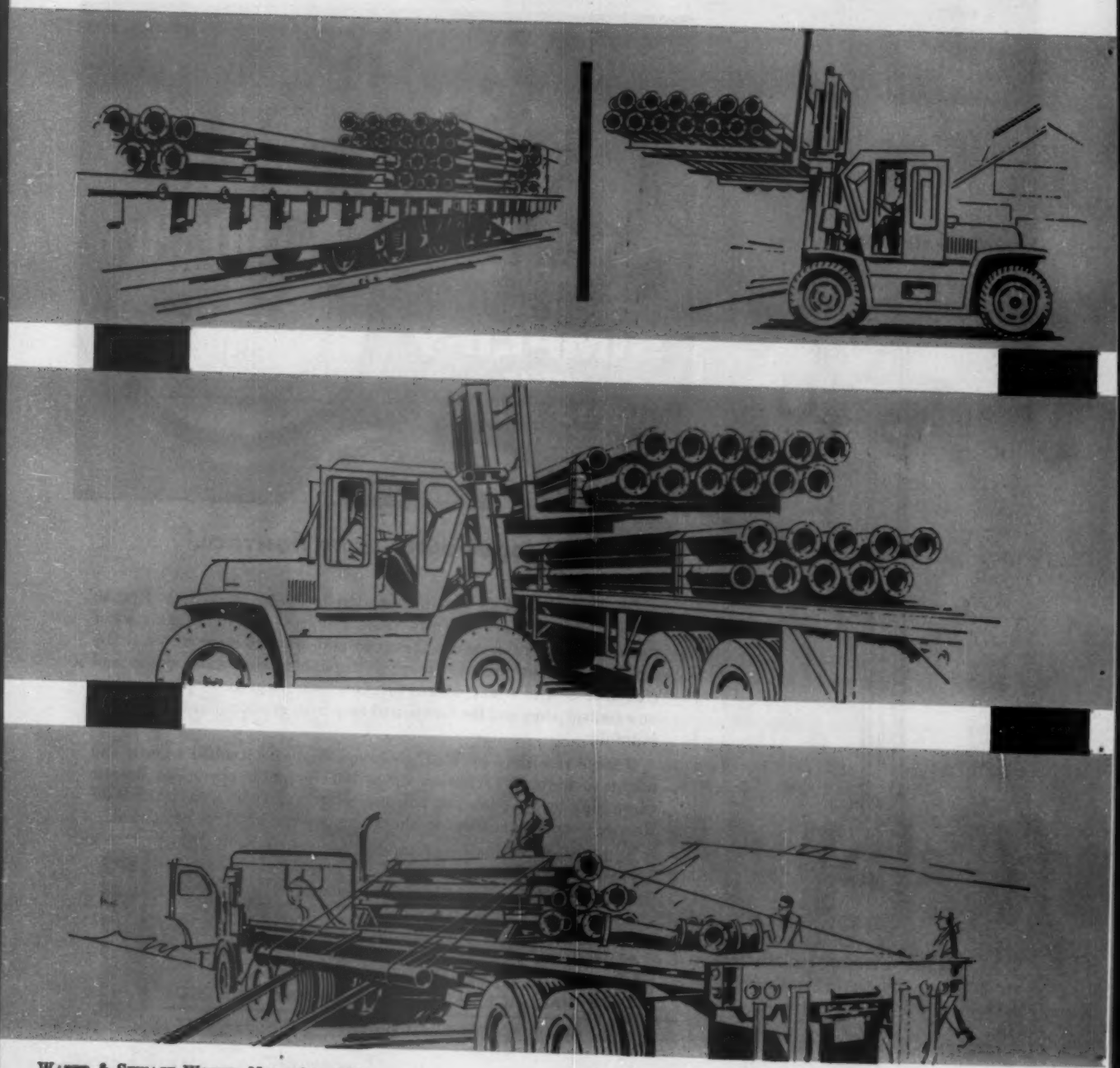
With remote residual recording and controlling by Wallace & Tiernan you centralize control... save time and operating expense... extend the advantages of the Compound-loop method.

For more information, write Dept. S-142.94

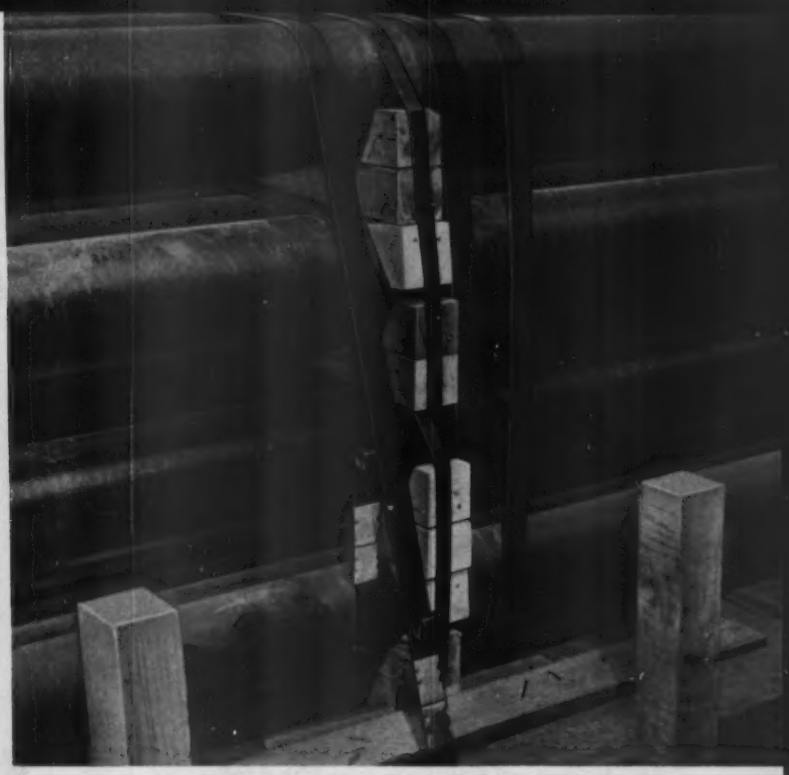
WALLACE & TIERNAN INCORPORATED
25 MAIN STREET, BELLEVILLE 9, NEW JERSEY

GRIFFIN-20's PALLETIZING LOWERS YOUR HANDLING

SAVES TIME...REDUCES EFFORT!



Pallets can be used on *flat cars or flat-bed trailers.* Each pallet is banded by itself. Two pallets are banded together. The composite unit is then banded to the flat car or chained to the trailer bed. The pipe shipment moves safely as a unit.



COSTS!

UNIT UNLOADING

● A fork-lift truck can quickly and easily unload and store a carload of pipe in four "lifts." Unload it on the ground, or directly on your flat-bed . . . whichever is most convenient for you.

EASY HANDLING

● Pallets are specifically designed for multiple handling . . . and will fit either cars or trailers. Subsequent movement is fast, safe, and simple. Palletizing materially reduces both time and effort.

INDIVIDUAL UNLOADING

● Pipe can be unloaded individually off the side of either a flat-bed car or flat-bed trailer, by using skids. The overhead crane normally required for gondola unloading is no longer necessary.

Only Griffin-20 offers you so much!*

Palletizing reduces hidden handling costs . . . is less expensive to you and more convenient. Because of Griffin's unique method of loading, pallets are rugged enough to withstand *multiple handling*. Pallets can be stored where most convenient, for movement to your job site. This saves on labor in unloading, and in subsequent reloading of pipe onto flat-bed trailers for transportation to installation sites. These economies are in addition to more economical installation costs due to Griffin-20's modern 20-foot length which means 10% fewer joints. The economies of palletizing are evident in the following tabulation of what constitutes a pallet.

SIZE	PIECES	WEIGHT
4"	32	5 tons
6"	24	6½ tons
8"	18	7¼ tons
10"	14	6½ tons
12"	12	7¾ tons

If you have a pipe handling or storage problem, consult us.

GRIFFIN PIPE DIVISION

Griffin Wheel Company · Council Bluffs, Iowa

SALES OFFICES . . .

Chicago—SAcramento 2-6200, 445 N. Sacramento Blvd. . . . Marvin E. Simpson, *Dist. Mgr.*

Council Bluffs—322-6641, 2001 Ninth Avenue. . . . . John L. Larson, *Sales Rep.*

Denver—West 5-2427, 1400 W. Evans Avenue. . . . . John M. Masterson, *Dist. Mgr.*

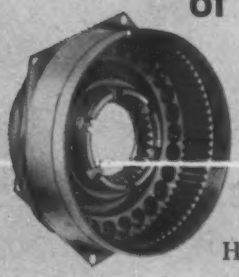
Kansas City—DRexel 1-5600, 1134 S. 12th Street. . . . . Thomas M. McGinley, *Sales Rep.*

St. Paul—Prospect 6-1521, 941 Johnson Parkway. . . . . William R. Colton, *Dist. Mgr.*

*THE TRADEMARK "GRIFFIN-20" IS THE PROPERTY OF GRIFFIN WHEEL COMPANY

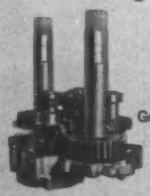
Engineered to jet engine and missile standards of precision tolerances and quality control

HUPP ELECTRODYNE
AUTOMATIC VALVE / CONTROLS



Jet Engine Starter Component

HUPP is a major producer of gearing, hydraulic assemblies and components for jet and rocket engines, missiles, space vehicles, air frames and ground support equipment for military and commercial aviation.



Gear Box Sub-Assembly

Electrodyne Automatic Valve Controls are designed and built to the same high standards of precision manufacture, extreme tolerances and quality control established by HUPP for its production of components for the aviation industry.

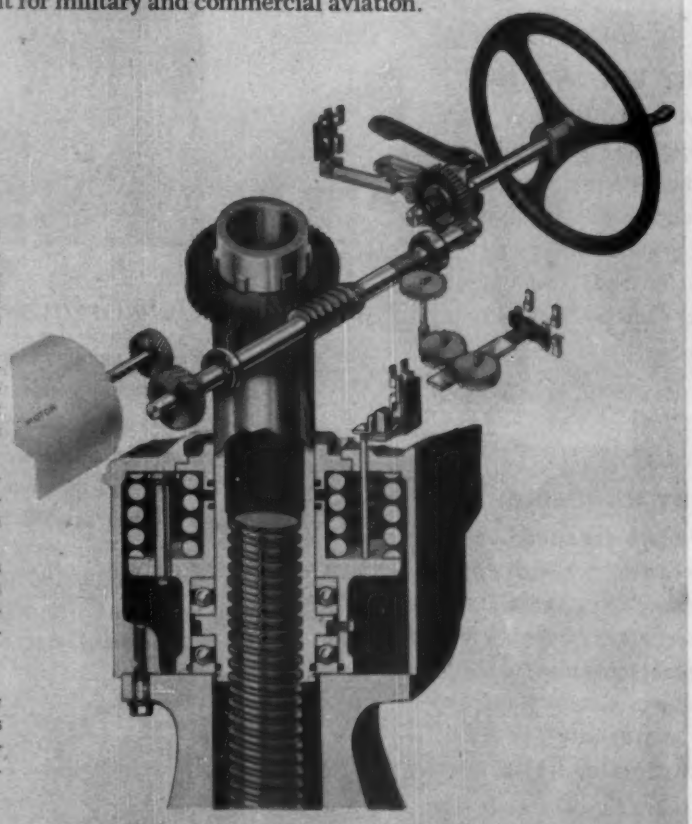
HUPP has unique capabilities and comprehensive facilities for precision machining . . . welding . . . fabricating . . . heat treating . . . and plating of standard, high temperature and "exotic" metals

Quality control is basic at HUPP. Extensive resources for testing include air-conditioned gear laboratory and walk-in X-ray rooms.

Electrodyne Automatic Valve Controls are currently being used in the oil and gas industries, water and wastes treatment installations, chemical and power plants, nuclear reactors and maritime applications.

• • • •

Parts and service are available promptly through HUPP *Electrodyne* representatives from coast to coast. We will be glad to supply detailed information about *Electrodyne*. Write or call us today.



originally developed by CUTLER-HAMMER

Precision Worm and Ring Set

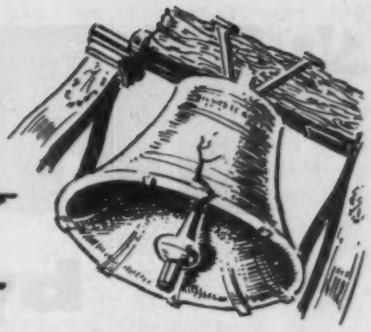
HUPP produces a complete line of *Electrodyne* Automatic Valve Controls with refinements to meet the demands of modern automation techniques.

HUPP Aviation Division HUPP CORPORATION

6633 WEST 65th STREET • CHICAGO 38, ILLINOIS • POrtsmouth 7-2100

ELECTRODYNE VALVE CONTROLS . . . GEAR PUMPS AND MOTORS . . . PRECISION INDUSTRIAL, AIRCRAFT AND MISSILE GEARING AND COMPONENTS

PHILADELPHIA, PA.*



chooses

TYLOX

RUBBER PIPE GASKETS

TO

- **PREVENT INFILTRATION**
- **WHIP DETERIORATION**
- **REDUCE PIPE-LAYING COSTS**

* **PROJECT:** TYLOX-coupled Storm-Sanitary sewer for city of Philadelphia, Pa.

ENGINEERS: Dept. of Water, Philadelphia, Pa.

CONTRACTOR: Globe Contracting Co., Upper Darby, Pa.

PIPE: 72" Concrete culvert pipe—United States Concrete Pipe Co., 12" Vitrified Clay Pipe—Universal Sewer Pipe Corp.

For its new combination storm-sanitary sewer shown here under construction, the city wanted long-lasting, low maintenance lines—built within the budget. Engineers wanted leak-proof lines that would stay leak-proof. Contractors wanted fast pipe jointing to help offset high construction costs. Here's how the choice of Tylox Rubber Gaskets helped meet all three requirements efficiently and economically:

1—TYLOX Gaskets have **seven** sealing ribs that "pack" pipe joints tight by compression. Natural resilience of the rubber **keeps** the seal watertight. Sewage treatment costs are reduced, and root and sediment problems are prevented.

2—TYLOX Gaskets speed pipe laying through fast assembly, and by eliminating trench work delays . . . mud and water can't slow up work, and laid line may be backfilled immediately. Installation costs are reduced.

3—TYLOX Gaskets are made of rubber specially compounded for immunity to sewage and industrial waste acids. Under ground and under compression, TYLOX outlasts the pipe itself.

5087

Send for this brochure

It contains engineering data and shows typical TYLOX installations the world over. Read why TYLOX was specified, and take advantage of TYLOX on your next pipe project.

HAMILTON KENT MANUFACTURING COMPANY

KENT, OHIO

427 West Grant Street Orchard 3-9555

*MM tapping sleeves by MUELLER®

*MINIMUM MAINTENANCE

. . . of Tapping Sleeve inventory is the money-saving service Mueller offers because . . .

MUELLER Tapping Sleeves and Valves provide a means of running a lateral with a minimum of inconvenience that means *extra* user benefit. The tapping valve itself has Mueller's exclusive four point wedging mechanism. The heavy-duty construction and extra length of the tapping sleeve actually strengthens the main at the point of connection. A Mueller Mechanical Joint Sleeve for a specific nominal size will fit all classes of cast iron pipe regularly used by selecting one of two sets of gaskets.

If any doubt exists as to the class of pipe to be uncovered, the operator takes both sets of gaskets to the job site. By stocking both sets of gaskets he may use either the duck-tipped gaskets for centrifugally cast pipe or the plain end gaskets for Class D pit cast pipe.

This simple detail of design is typical of many extra features of Mueller AWWA Tapping Sleeves and Valves. It is also typical of the great attention to detail in research, design and engineering that becomes a part of every Mueller product used by the water industry. For complete information write . . .

MUELLER CO.
DECATUR, ILL.

Factories at: Decatur, Chattanooga, Los Angeles
In Canada: Mueller, Limited; Sarnia, Ontario

5525

Equipment News

CONTINUED FROM PAGE 23A

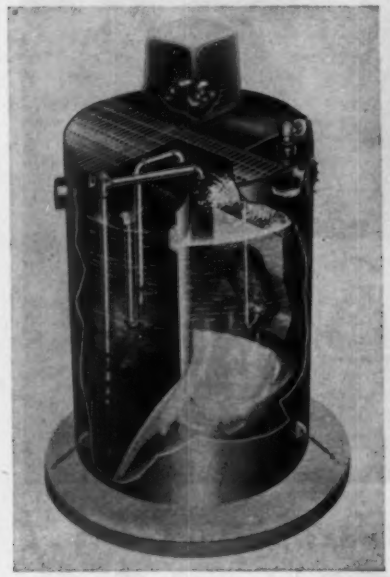
deck" cover is a statically determinate structure, basically simple in design and construction. The steel plates are ¼" thick. Insulation is of 1½" thick fiberglass material to which a thin fiberglass mineral surface roofing is added.

A weighted pontoon around the periphery is a structural member designed for torsion, bending and compression. A single roller guide banishes possible sidethrust on the tank wall. This "plate and pontoon" design minimizes tip and makes submergence impossible.

The hazard of explosion between the cover and the roof of the truss type floating cover is eliminated, and the single plate construction reduces the dead load to 15 lbs per square foot. These covers, as large as 60 feet in diameter, can be assembled complete outside the tank and lifted by contractor's crane into position. Thus tank and cover can be constructed simultaneously. Savings in erection costs are substantial.

Steel Sewage Treatment Tank
1109

Chicago Pump, Chicago, Ill., announces the availability of "Rated-Aeration SS", a factory-fabricated



small cylindrical steel sewage treatment tank. The unit uses the aeration process of sewage purification originally developed by the company and used in more than 700 installations of all types.

The compactness of "RateAeration SS", low original cost, low operating and maintenance costs and high efficiency make it the answer to sewage treatment problems for small communities, shopping areas, motels, factories, resorts, country clubs, etc. Completely odor and nuisance free, the steel unit can be installed above, or below ground, adjacent to, or away from buildings. Completely standardized, and packaged, the unit incorporates a comminutor, aeration tank, forced air blowers, clarification compartment and a sludge air lift pump. The clog-proof Hydroshear aeration system utilized provides high oxygenation, thereby increasing the purification power of the system.

CONTINUED ON PAGE 92A

SPEAKING OF PUMPS!

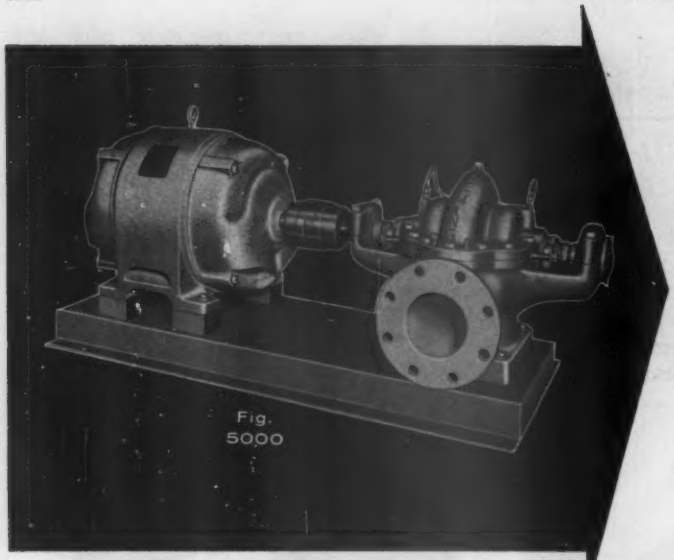
Specifying or buying pumps is a big responsibility. You must be sure the pump you select will operate efficiently, economically and dependably "around-the-clock" or in emergencies.

C. H. Wheeler can help you! We make the type pump you need—centrifugal, mixed or axial flow, both horizontal and vertical—in a wide range of capacities and heads.

Also, we can assist you in designing your pump installation, whether it be for municipal or industrial water supply, sewage, drainage, irrigation, flood control, fire protection, heating, air conditioning, or steam power plant services.

We've been designing and manufacturing quality pumps for almost three quarters of a century, so you know when you specify or buy C. H. Wheeler pumps, you can depend on them. Consult your local representative or write for more information.

C. H. WHEELER MFG. CO.
19th and Lehigh Avenue, Philadelphia 32, Pa.
Centrifugal, Axial and Mixed Flow Pumps • Steam Condensers • Steam Jet Vacuum Equipment • Marine Auxiliary Machinery • Nuclear Components



SPLIT-CASE CENTRIFUGAL

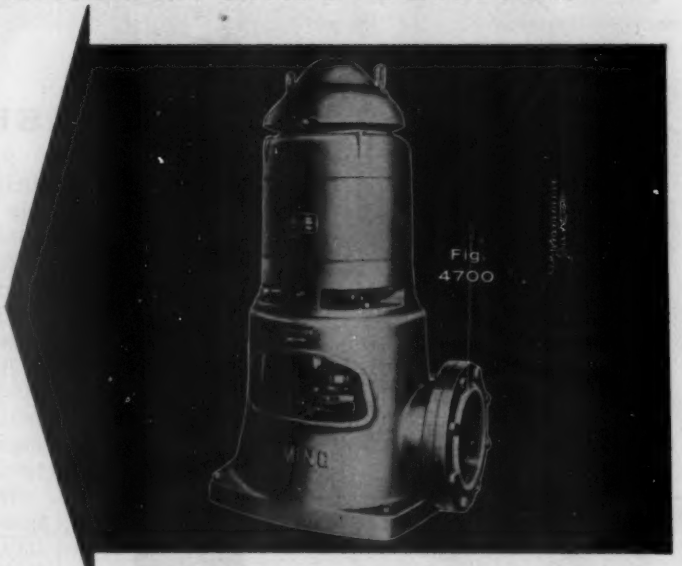
Provide peak performance for heavy, continuous pumping of clear water. The Deming Split-Case Centrifugal is a rugged unit with all rotary elements in perfect balance, both statically and dynamically, assuring vibrationless operation. A full range of sizes from 2" to 14".

DEMING PUMPS

FOR EFFICIENT WATER WORKS SERVICE

VERTICAL TURBINE

Dependable, economical. Designed and manufactured to meet discriminating Water Works installation standards. Deming Vertical Turbines are available with any type of power in a wide range of capacities to meet your specific requirements.



Ask for a recommendation on your next project

The DEMING Co.

1188 BROADWAY • SALEM, OHIO

drink up...

AND GIVE THE TOWN A GOOD NAME!

AQUA NUCHAR
ACTIVATED CARBON
for taste and odor control

Do people judge the administration of your town by the water you serve them?

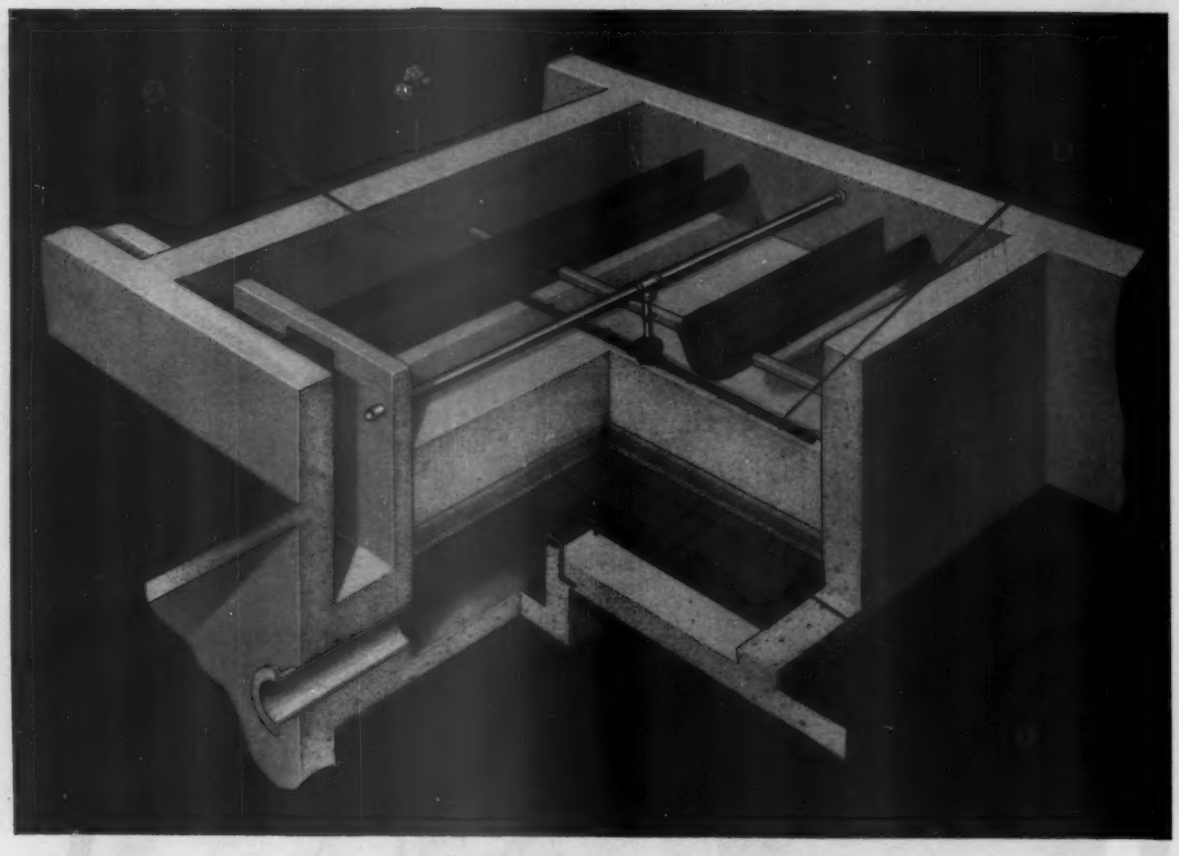
To be sure the impression you make is always favorable, depend upon AQUA NUCHAR and daily threshold odor tests. Daily testing tells you exactly how much or how little AQUA NUCHAR you need to do an effective control job surely . . . *and economically.*

Extremely low concentrations disperse billions of porous particles of AQUA NUCHAR throughout the water. Taste-and-odor-causing substances are quickly entrapped and removed by adsorption. And the cost averages only a few cents a day.

Our research staff is always available to help you solve your taste-and-odor-control problems.

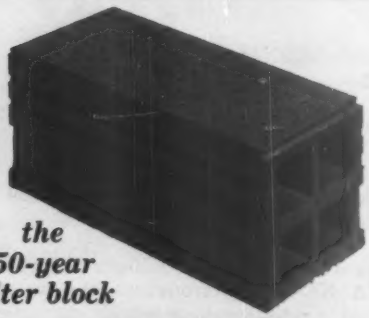
West Virginia Pulp and Paper
INDUSTRIAL CHEMICAL SALES DIVISION

230 Park Ave., New York 17 · Philadelphia National Bank Bldg., Philadelphia 7 · 35 E. Wacker Dr., Chicago 1 · 2775 S. Moreland Blvd., Cleveland 20



FROM TOP TO BOTTOMS . . . SPECIFY LEOPOLD

- **Leopold Glazed Tile Filter Bottoms.**
- **Leopold Fiberglass-Reinforced Plastic Wash Troughs.**
- **Leopold Rotary Surface Washers.**



the 50-year filter block

Leopold

F. B. LEOPOLD CO., INC., Zelienople, Pa.

Exclusive Canadian Representative:
W. J. Westaway Co., Ltd., Hamilton, Ont.

Now you can specify an entire non-corroding filter installation from Leopold . . . your experienced source of supply. For lowest "over-the-years" cost, choose performance-proved Leopold glazed tile filter bottoms, built to last at least half a century. Tough Leopold fiberglass-reinforced wash troughs require no painting or other expensive maintenance. And new Leopold self-propelled rotary surface washers complete the package with a dependable product that's guaranteed for five years against mechanical and functional defects. Leopold filter plant equipment is used in thousands of plants throughout the country, on both new and rehabilitation projects. Choose these time-tested products by Leopold . . . for your complete filter needs. Write today for facts and figures.

F. B. LEOPOLD CO., INC., Zelienople, Pa.

☐ Please send literature on Leopold Glazed Tile Filter Bottoms.
☐ Please send literature on complete line of Leopold products.

Name_____

Affiliation_____

City_____ Zone____ State_____

clean, safe
WATER
for generations to come

Our nation's population growth requires water—clean water, and lots of it! Controlling pollution of lakes, streams and rivers means better public health and water supplies, new and improved vacationlands abounding in fish and wildlife. Local industries also benefit from unpolluted water supplies. Up-to-date sewage treatment facilities insure these continuing benefits. The following cases show actual benefits achieved by planned water pollution control.

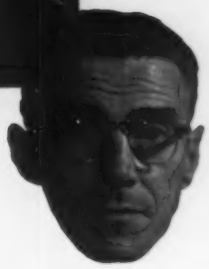
Everybody benefits from clean water

Abundant usable water is every American's birthright—and responsibility! Modern living takes good water away...modern technology alone can restore it.

Clean, sparkling river water flowing into Wyoming's Glendo Reservoir makes it a great place for water sports!

The Glendo Reservoir on the North Platte River was ideal for recreation except for the untreated sewage being poured into the river by every town for 100 miles upstream. Then they all joined in a highly successful clean-up campaign. Ridding the river of dangerous wastes not only took care of a serious public health problem—it gave everyone a delightful new recreation attraction after the dam was built. Boating, swimming and fishing bring many vacationers to the area each year.

"They're catching bass in the Walnut River for the first time in 35 years!" say local fishermen. Oil field, refinery and municipal wastes spoiled one of the prettiest rivers in southern Kansas. But the communities and industries along the Walnut River set up a *pollution abatement program* and each cooperated to carry it out. They've built new sewage treatment plants, eliminated oil field brines and set up waste treatment facilities at refineries. The river is being returned to its original beauty—a natural resource to be proud of!



"Our water clean-up brought us new industry and jobs," says Mayor J. E. Keech, Cumberland, Maryland. The city built a new sewage treatment plant (above) that will take care of all home and factory wastes, even with the growth expected in the next ten years. And that's one important reason Pittsburgh Plate Glass Company came to Cumberland! Their new factory will bring jobs for nearly a thousand people.

Right next door to luxury homesites . . . treatment plant doubles as popular marina!

An attractive and useful asset to the community is the sewage treatment plant at Clearwater, Florida. Its appearance would do credit to a fine yacht club. There are 45 boat slips for public use at the Marina Station. Planned for the future, the plant's capacity for treating wastes will be more than adequate for the population expected when the area is fully developed.

Treatment plant on a boulevard wins favor for engineers and city officials

The Coral Gables, Florida, sewage treatment plant is truly a civic showplace. Walls are decorated with colorful scenes by famous artist John St. John. A well-designed, odor-free treatment plant is a credit to a community wherever it's located!

HERE'S HELP IN GETTING PUBLIC SUPPORT FOR ACTION ON POLLUTION PROBLEMS IN YOUR AREA

The pages you have just read relate a story that needs telling to the public. That's why PCA is reprinting this colorful insert—with a new fourth page—folded for easy mailing (shown at right.)

This mailing piece is available in quantity for use locally where help is needed to inform the public as to the urgency for obtaining adequate pollution control facilities.

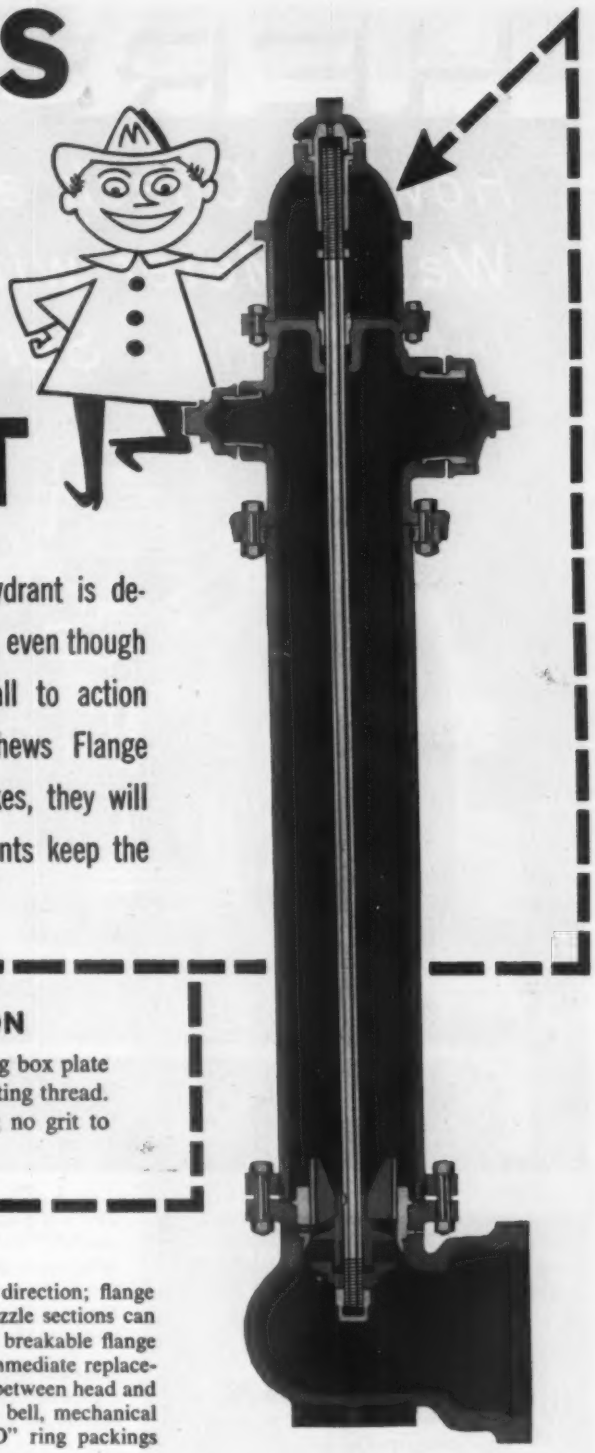
For further information about this folder, or for help of any kind in planning your clean-up programs—just call on PCA.

PORTLAND CEMENT ASSOCIATION
33 West Grand Ave., Chicago 10, Illinois

MODERN concrete

A national organization to improve and extend the uses of concrete

MATHEWS FLANGE BARREL HYDRANT



The most important single feature of any hydrant is dependability. It must be operable when needed, even though it has remained idle for years and the call to action comes during a hard freeze. Install Mathews Flange Barrel Hydrants, and when emergency strikes, they will be ready to serve! These outstanding hydrants keep the neighborhood safe.

DRY HEAD CONSTRUCTION

Cast integral with the nozzle section, the stuffing box plate keeps water and sediment away from the operating thread. No ice to jam the thread in freezing weather; no grit to wear out the operating thread.

AND THESE FEATURES, TOO:

A swivel flange permits nozzles to be faced in any direction; flange barrel reduces accident costs because top cap and nozzle sections can usually be salvaged from broken hydrant • Optional breakable flange and stem coupling snaps in traffic accident, permits immediate replacement without excavating • Extension piece insertable between head and barrel or between barrel and elbow • Available with bell, mechanical joint or flange pipe connections; conventional or "O" ring packings

Conform to latest AWWA specifications

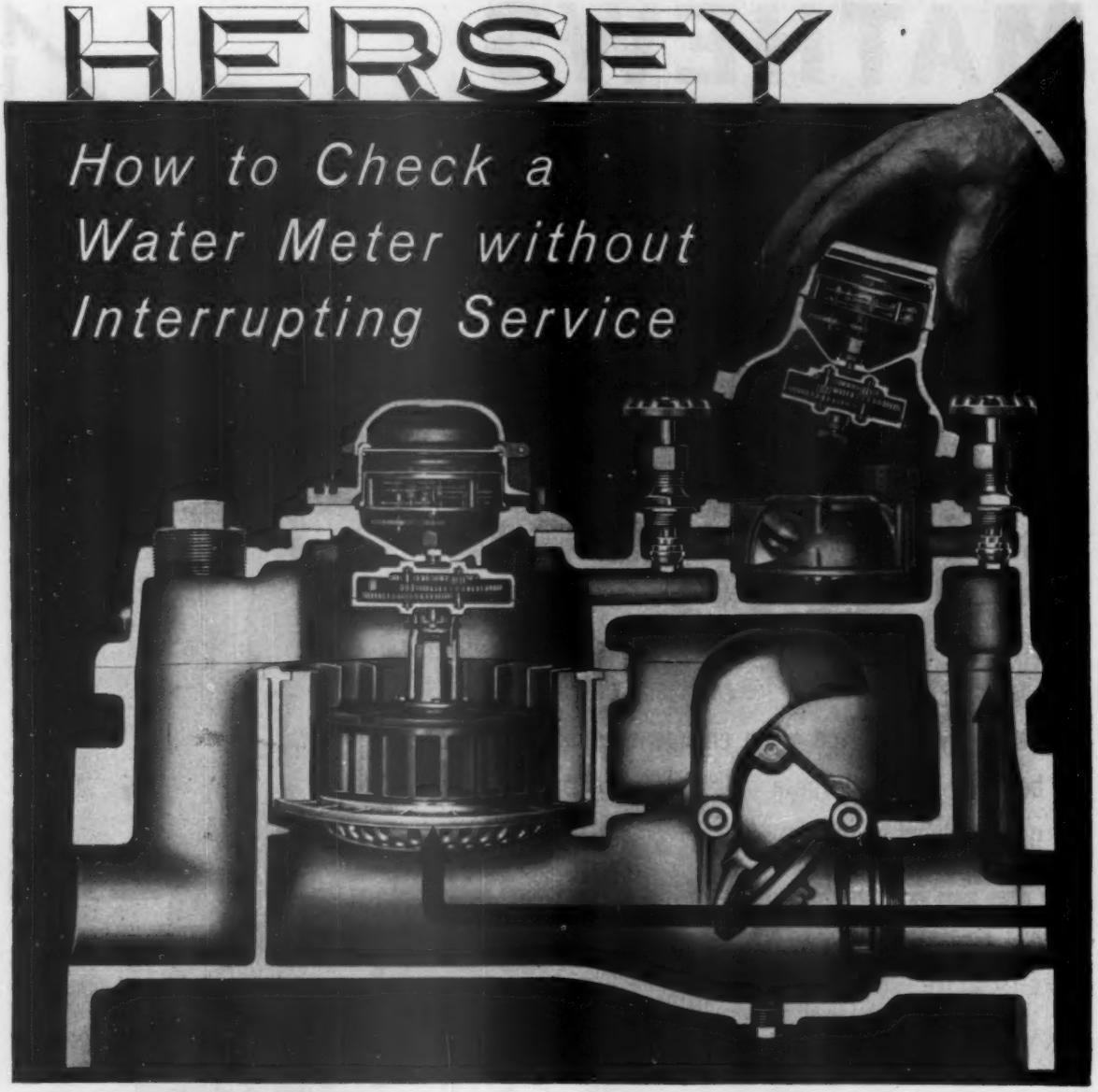
R. D. WOOD COMPANY

Public Ledger Building, Independence Square, Philadelphia 5, Pa.

Manufacturers also of Mathews Modernized Hydrants, R. D. Wood Hydrants, R. D. Wood Gate Valves, and "Sand-Spun" Pipe (centrifugally cast in sand molds)

HERSEY

How to Check a Water Meter without Interrupting Service



4″ size shown above

That's a Hersey Compound Water Meter having its by-pass meter checked – *without shutting off the main line.* This is one reason these meters are the No. 1 choice when both large and small rates of flow are to be measured. Another reason is the high degree of accuracy obtained by using the extremely sensitive Hersey conical disc type meter on the by-pass.

A special feature of the Hersey Compound Meter is the exclusive swing type lever valve which diverts small flows through the by-pass but, when opened by a large demand, offers no resistance to the flow of water.

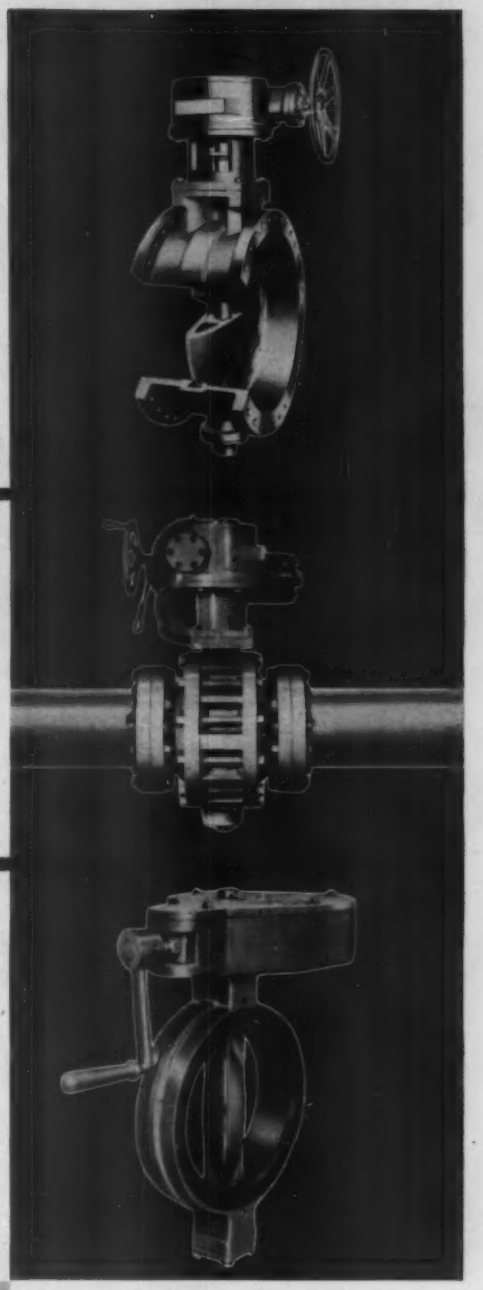
These meters are available in sizes from 2″ to 10″ inclusive (2″, 3″, 4″, 6″ all bronze cases–8″ and 10″ galvanized iron cases). Write for more facts.

Hersey-Sparling
Meter Company
HERSEY PRODUCTS
DEDHAM, MASSACHUSETTS

Branches: Atlanta, Boston, Chicago, Cleveland, Dallas, Denver, Kansas City, Mo., Los Angeles, New York, Philadelphia, Portland, Ore., San Francisco, Seattle.

WATERWORKS VALVES for the '60s!

These new, modern, rubber seat valves are especially engineered to meet the demands of the next decade—a decade in which dramatic population increases will place ever increasing loads on waterworks and sewage equipment.



NEW high pressure Butterfly Valves

for pressures to 150 psi. In sizes 4" through 72"

The R-2 series of Rubber Seat Butterfly Valves meet or exceed all AWWA Specifications for high pressure valves, and offer operating advantages far beyond basic requirements. The time-proven Henry Pratt features are now augmented by such new design features as: *Adjustable seat* that can be tightened (or even replaced) without removing shaft or disc. *Lower seating torque* lowers actuator cost and provides remarkable ease of operation. The R-2 is completely bubble-tight to 150 psi and offers longer operating life than ever before possible. Write for complete information.

NEW Pratt rubber seated Ball Valve

in 150 and 250 psi ratings. Sizes 10" through 48"

The famous Henry Pratt Company rubber seating philosophy has now been applied to the Ball Valve. This pioneering achievement enhances the inherent advantages found in Ball and Cone Valves. Just as the disadvantages of metal-to-metal seated gate and butterfly valves were eliminated, and the use of rubber seat butterfly valves made a waterworks industry standard by the original Pratt design, we expect the use of resilient seating in the Pratt Ball Valve to add a new perspective to waterworks valving.

Write for Bulletin BA-1B

NEW Monoflange Mark -II

for pressures to 150 psi. Sizes 4" through 20"

No valve is easier to install or operate. The Monoflange fits conveniently between existing pipe flanges—no gasket is necessary. With completely tight shut-off at 150 psi, the Monoflange Mark II finds many applications where economy is paramount, but long life is necessary. Fully complies with all structural and operator requirements of AWWA Specification C504-58 for rubber seat butterfly valves with the exception of body configuration.

A most complete 60 page catalog has been prepared which contains all necessary information. Write for Bulletin 10-B.

HENRY PRATT® *Creative Engineering for Fluid Systems*

HENRY PRATT COMPANY
319 W. Van Buren Street, Chicago 7, Illinois
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From the moment it is installed, cast iron pipe begins working—will deliver its full flow of water for over a century.

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An interesting feature was the uncovering of distribution mains constructed of cast iron pipe manufactured in 1887. The pipe was in excellent condition and was put back in water service.

Cast iron pipe is always working. In fact, once it is installed, one can generally anticipate no major repairs or replacements for at least a century.

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THE MARK OF THE 100-YEAR PIPE

240 CUTS FAST ACCURATE 34"x46" TRENCH FOR CONCRETE PIPE

This Cleveland 240 Trencher is digging trench 34 inches wide by 46 inches deep for installation of 12-inch concrete pipe in an underground irrigation system in Lunn County, Texas. It is one of a fleet of more than ten Clevelands employed by Gifford-Hill-Western, Inc., one of the leaders in the design, engineering and installation of irrigation systems throughout the Southwest. Gifford-Hill-Western uses its Clevelands for fast accurate digging of square-bottom trench for 12, 15 and 18-inch concrete pipe with a normal cover of 30 inches.

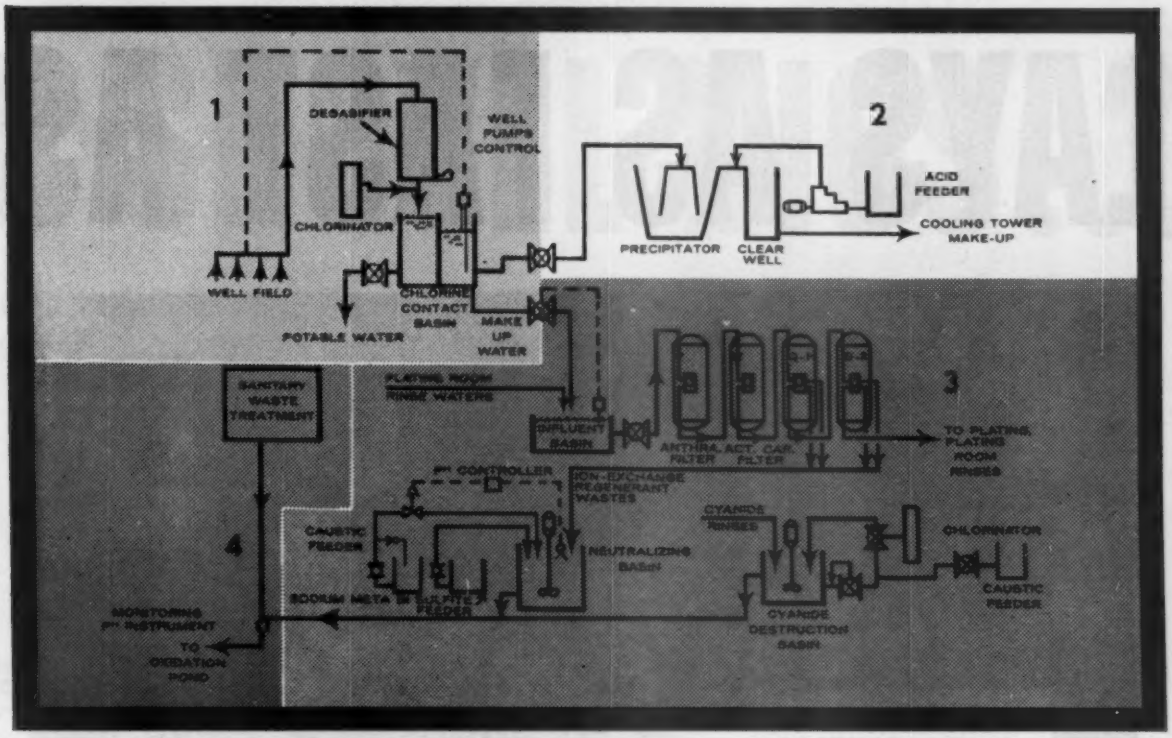
There are 10 rugged models in the complete Cleveland Trencher line—with a digging range of 8 to 52 inches wide, down to 8½ feet deep—for every type of trenching job—from house footings and utilities lines up to 36-inch cross-country pipelines. Ask your local distributor for the Cleveland Full Line Bulletin L-109... or write:

The Cleveland 240 is used on all types of trenching jobs... irrigation and drainage projects... cross-country pipelines ... gas, water and sewer lines... conduit and cable work... any trenching job up to 3' wide, down to 6' 3" deep.

CLEVELAND TRENCHER

THE CLEVELAND TRENCHER CO., 20100 ST. CLAIR AVE., CLEVELAND 17, OHIO

FLUIDICS* AT WORK



How many of these water and waste treatment ideas can you use profitably?

From well point to waste disposal this new system now serving the Electro-Mechanical Research Company, Sarasota, Florida, is packed with ideas that can help *you* solve similar problems—and each idea was brought to reality with equipment supplied by Permutit, as prime contractor:

1. Well-water treatment (upper left in diagram) handles a minimum flow of 160 gallons per minute from a well field—84 gallons for industrial cooling, 10 gallons for plating rinse make-up, and the balance for potable use. All this raw water is degasified and treated in a Permutit equipment system.

2. Cooling water undergoes further treatment (top right) for reduction of carbonate and bicarbonate alkalinity, by means of a Permutit® Precipitator and acid feeder.

3. Plating room rinse-water demineralizing (center and lower right). A complete Permutit system saves water, saves heat, treats regenerant wastes, and provides high-quality demineralized water for plating rinse. Make-up and plating rinse water is processed through an anthracite filter to remove suspended solids, a Carbo-Dur filter to remove organics, a Permutit Q-H cation exchanger, and a Permutit S-2 anion exchanger. This demineralized water is then ready for use. After plating rinse operations, water is recycled, treated and re-used. Wastes —including cyanide rinses, regenerants, and others—are batch treated.

4. Sanitary waste treatment (lower left) was designed to handle 20,000 gallons per day, treating them first in an Imhoff tank, followed by high-rate bio-filtration, secondary clarification and chlorination.

The entire system was designed by Smally, Wellford and Nalven, Sarasota, Florida, consulting engineers. *Your* engineering consultants can help you obtain similar results. Talk it over with them, or write for our Bulletin 4433, "Water Treatment Equipment," and/or Bulletin 4486, "Equipment for Treating Industrial Wastes."

Permutit Division, Dept. WS-110, 50 West 44th Street, New York 36, New York.

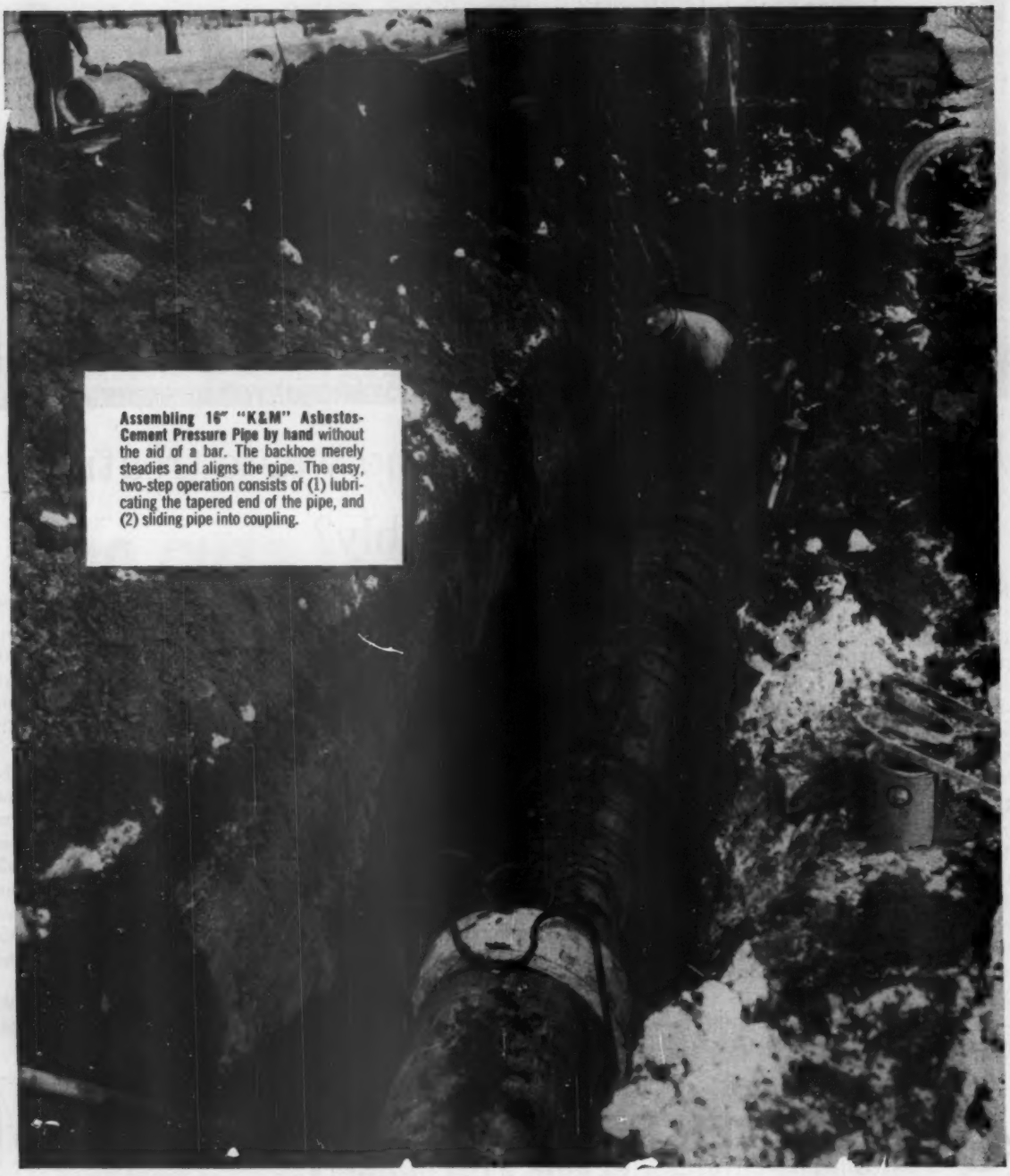
PFAUDLER PERMUTIT INC.

Specialists in FLUIDICS... the science of fluid processes

*FLUIDICS is the Pfaudler Permutit program that integrates knowledge, equipment and experience in solving problems involving fluids.

"'K&M' ASBESTOS-CEMENT

LAYS AS FAST AS



Assembling 16" "K&M" Asbestos-Cement Pressure Pipe by hand without the aid of a bar. The backhoe merely steadies and aligns the pipe. The easy, two-step operation consists of (1) lubricating the tapered end of the pipe, and (2) sliding pipe into coupling.

PRESSURE PIPE

A SHOVEL DIGS..."

G&B Construction, Inc., Youngstown, Ohio, installs 4½ miles of "K&M" Asbestos-Cement Pressure Pipe for the Austintown District of Mahoning County, Ohio

"You can lay 'K&M' Pipe as fast as a shovel can dig. There is nothing that will hold you back with this pipe. When you can lay a 16" water line, and it goes in as easy as an 8" water line, what more could you ask? They've got a good joint with that FLUID-TITE® Coupling . . . the pipe is wonderful to put together. Of all the 'K&M' Pipe we've laid, we never had a coupling break."

Those are the comments of Louis Gulfo, partner with Mike and James Bertilacci in G&B Construction, Inc. They installed "K&M" Asbestos-Cement Pressure Pipe in bitter cold, during February and March 1960. However, neither rain, snow, nor mud interrupts the installation of this modern pipe. The exclusive, patented "K&M" FLUID-TITE Coupling and the simple fitting procedures required make assembly easy.

Little or no maintenance will face Mahoning County, which built and will operate the system for a year, or the City of Youngstown, Ohio, which will then take it over. Being non-metallic, "K&M" Asbestos-Cement Pressure Pipe won't rot, corrode, or tuberculate, and is immune to electrolysis. The suppliers of this pipe were Trumbull Plumbing Supply Co., Warren and Youngstown, Ohio.

Now, in addition, you may use quality "K&M" Plastic Pressure Pipe in the same system with "K&M" Asbestos-Cement Pipe, if desired.

Write today for more information on "K&M" Asbestos-Cement Pressure Pipe to: Keasbey & Mattison Company, Ambler, Penna. Dept. P-9110.

K·M BEST IN ASBESTOS

Keasbey & Mattison at Ambler

Left to right: Louis Gulfo, G&B Construction, Inc.; Dale MacCleary, sales manager, Trumbull Plumbing Supply Co.; James Bertilacci, G&B Construction, Inc., Burke Lyden, Asst. Chief Engineer, Youngstown, Water Dept., Jim Bisciglia, Asst. Engineer, Mahoning County, and J. Henry Painter, Trumbull Supply Company.

3 miles of 16" "K&M" Asbestos-Cement Pressure Pipe were installed. Here, we see it ready for installation along Webb Road, in Austintown Township. In branching from the 16" water line, Mahoning County used 1 mile of 12" "K&M" Asbestos-Cement Pressure Pipe and ½ mile of 8" "K&M" Asbestos-Cement Pressure Pipe. Specifications call for 90 lbs. pressure when line is in operation serving 16,000 residents.

NEW SUTORBILT SERIES 3200 BLOWERS AND GAS PUMPS

with one-piece shafts for greater efficiency at increased horsepower and pressure ratings

New Series 3200 Sutorbilt lobe-type rotary positive blowers and gas pumps feature *one-piece* shafts. Forged from a single billet of 4140 alloy steel, they are slip fitted through—and bolted to—the impellers at the gear end.

Why a One-Piece Shaft? These heavy duty, high performance units must operate safely from 800 to 20,000 cfm at pressures from 2 to 10 psi. Incorporating this advanced shaft design in all 42 sizes eliminates using the drive impeller to transmit power . . . and greatly reduces the torsional deflection of the shaft between the timing gears and the impellers. And this one-piece shaft also eliminates adding outboard bearings for V-belt drive with normal working loads.

Other Outstanding Features include oversize heavy duty, anti-friction roller bearings with lip-type oil seals, machined sub-bases, alloy steel precision machined helical timing gears piloted to the shafts for concentricity, close grain cast iron impellers and a reversible oil pump with an oversize sump that eliminates the need for an oil cooler at ambient temperatures below 125°F. In gas and high vacuum pumps, mechanical seals prevent leakage or gas contamination.

For more information and detailed specifications on these powerful, peak-performance units, write today, Department H.

Representatives in principal cities. Consult your classified telephone directory.

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CORPORATION, 2966 EAST VICTORIA ST. • COMPTON, CALIF.
SUBSIDIARY OF FULLER COMPANY • CATASAUQUA, PA.

FULLER COMPANY GENERAL

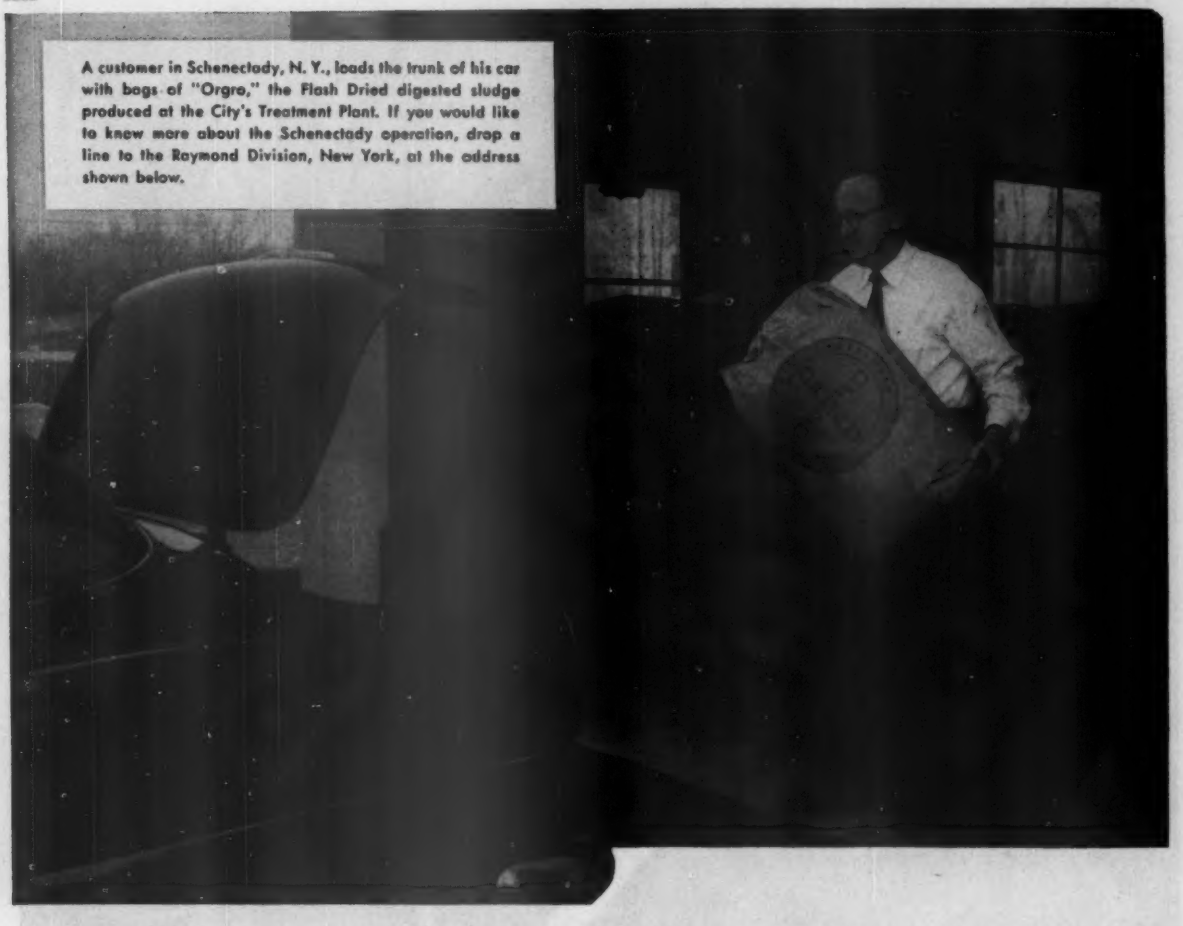
Right! There's no rodding necessary because roots just can't get in and clog up Transite®, *the white sewer pipe.* Johns-Manville's patented Ring-Tite® Joint keeps out even the thirstiest of these system disrupters. And it remains impenetrable for the duration of the line. Remember, by keeping roots out you eliminate the major cause of expensive periodic cleanouts . . . an expense which can run over $2,000 annually per mile of pipe in a system having joints that are not tight.

Actually, Transite starts saving you money from the very beginning. Its long length and light weight make this asbestos-cement pipe easy to handle in trucking, moving and lowering into the trench. Once in the trench, Transite adjusts easily and speedily to accurate line and grade. And that Ring-Tite coupling makes a dependable joint quickly and effortlessly. You'll save on operation costs too, because Transite's low coefficient of friction ($n = 0.010$) means faster flow and shallower trenches.

Hartley knows what he's talking about when he says that Transite can cut *your* sewer system costs. Get all the details on Transite, the white sewer pipe. Write Johns-Manville, Box 14, WS-2, New York 16, New York. In Canada: Port Credit, Ontario.

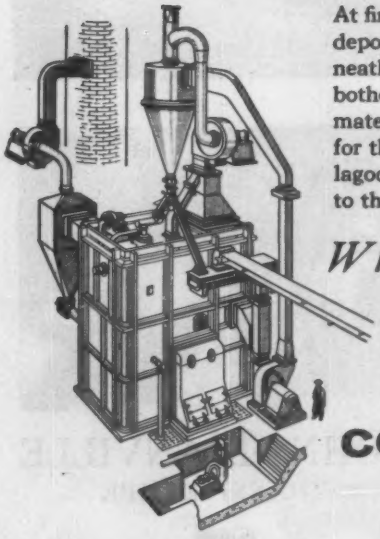
JOHNS-MANVILLE
TRANSITE PIPE

JM



A customer in Schenectady, N. Y., loads the trunk of his car with bags of "Orgro," the Flash Dried digested sludge produced at the City's Treatment Plant. If you would like to know more about the Schenectady operation, drop a line to the Raymond Division, New York, at the address shown below.

Can you think of a better way to dispose of sewage sludge?



At first glance, the trunk of a car may seem to be a peculiar place to deposit sewage sludge. But when the sludge is dry, sterile and neatly packaged, it can be a marketable commodity rather than a bothersome waste. When uncontaminated with noxious industrial materials, it is an excellent soil conditioner. Its sale produces revenue for the treatment plant, eliminates the nuisances of drying beds, lagoons and ash disposal and, at the same time, renders a service to the people of the community.

What's the best method of drying sludge?

It's the C-E Raymond Flash Drying System, a system used by communities large and small across the nation, a system proved in service and one which dries more filter cake than all other systems combined.

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RAYMOND DIVISION, 428 West Randolph Street, Chicago 6, Illinois

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C-E C-159

ALSO FLASH DRYING AND INCINERATION SYSTEMS FOR INDUSTRIAL WASTE DISPOSAL

ROILINE GAS ENGINES

are advanced, dependable, and proven in Municipal Service.

In-line 6, V-8, or V-12 cyls.—up to 706 hp.

HEAVY DUTY... LONG LIFE

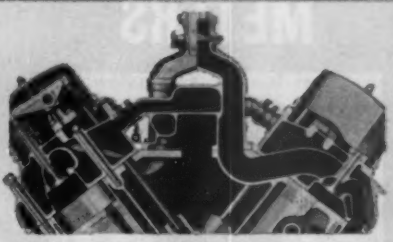
A look inside these engines reveals the rugged construction that can be relied upon for dependable service.

Internally ribbed crankcase gives solid crankshaft support. Extra rear main bearing absorbs side thrust.

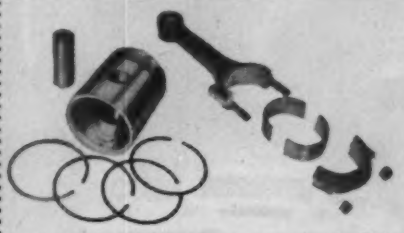
Large diameter, short in length, the rugged counterbalanced crankshaft handles power without vibration. It has generous bearing areas.

MORE POWER... BETTER ECONOMY

These ROILINE engines are the most modern, most powerful natural gas-butane-gasoline engines in their class.



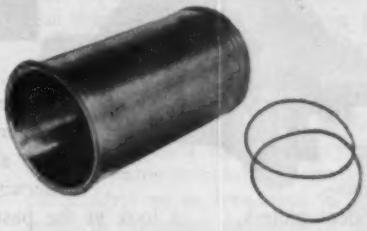
The "Easy Flow" manifold design provides perfect fuel and air distribution to all cylinders through large individual intake ports.



Aluminum pistons are taper cam ground. Full floating piston pins. Connecting rods have big wear-resisting replaceable bearings.

EASY MAINTENANCE... QUICKLY SERVICED

All wearing parts have replaceable bearing surfaces. *All* routine maintenance points are readily accessible.



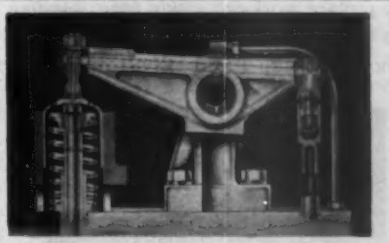
Long wearing cylinder sleeves are easily replaced and cost far less than reboring cylinder block and installing oversize parts.

Cylinder heads can be removed by one man without disturbing manifold, carburetor, or controls. Note guided valve mechanism.

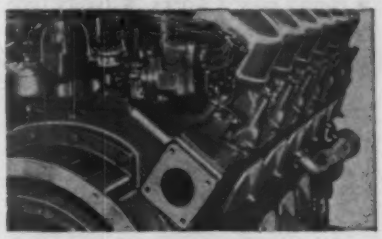
SMOOTH—QUIET... CLEAN—COOL

Benefits from newest design features mean more comfortable operating conditions and easier maintenance.

499 *Write for literature*



Hydraulic "Zero-Lash" lifters eliminate noise and adjustments and extend valve life. Engines are practically vibration-free.



Exhaust manifold is water cooled and integrally cast into the crankcase to provide cooler operating area and fast warm-up of the engine.

WAUKESHA MOTOR COMPANY, WAUKESHA, WISCONSIN / **New York • Tulsa • Los Angeles**
Factories: Waukesha, Wisconsin and Clinton, Iowa

NO OBSOLESCENCE WITH TRIDENT METERS

Being modern today is the continuous process of going out-of-date tomorrow. Look at the record of Trident design improvements and you'll find this statement is just as true of water meters as it is of automobiles . . . *with one exception.* ■ With Trident meters, your department is probably the only service in your community equipped with *built-in modernization* . . . a process which eliminates the high cost of obsolescence. ■ Here's how it works. ■ Every time you replace worn parts in a Trident disc meter, you automatically use *modern* parts identical to those in the *latest* model . . . parts embodying every thoroughly tested advancement known to the science of metering. Not only is repairing easy and economical, but also you actually *modernize* your Tridents as you go. ■ Take a look at the past 30 years. Think how much you're saving *this* year on Tridents installed back in 1930 . . . or even 30 years before that. ■ *All of the many design improvements now on our drawing boards continue this long standing Neptune policy.* It's your assurance that the Tridents you buy today will not be obsolete tomorrow. For personal proof, check your own records.

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Vol. 107, No. 11 • November 1960

A Scranton Gillette Publication

WATER & SEWAGE WORKS

Process improvements lower costs of getting fresh water by . . .

Multiflash Distillation of Sea Water

by F. C. LIVINGSTONE,
London, England

RESUME: Seventy-five per cent of the world's potable water distilled from sea water is produced by some 56 distillation plants employing the multiflash system. Many years of experience and research have led to improvements of this system and all have been incorporated in this latest design. The process, its operation and costs are discussed.

■ THE DISTILLING of sea water to obtain supplies of fresh water is far from a new idea; in fact, it is almost as old as the water-kettle and has been used on board ships for nearly a hundred years. Similar distillation plants have also been set up on a larger scale to provide water to land areas where there is absolutely no drinking water available. This has been particularly necessary in some of the world's most important oil fields and at strategic ports, such as Aden and Gibraltar.

From the elementary equipment used in the earlier efforts to obtain fresh water from the sea, new plants have been developed which can perform the operation at a favorable cost.

In recent years, distillation plants have been designed to meet requirements in areas where a fresh water supply is available but inadequate. Also, it is now recognized that in some cases the use of sea water can be more economic than the collection of fresh water.

This is not to say that the cost of building reservoirs has increased to the cost level of evaporation plants, but rather that the advances made in evaporation plant design are such that the cost of water produced by them has been progressively lowered over the years.

Due to the growth of industry, the expansion of housing and the rising requirements of public health, as well as an increasing improvement in the standard of living, there is evidence that the public is compelled to regard water as a natural resource to be conserved. Supplies have many times been outgrown and reservoirs, pipelines and aqueducts are constantly being installed in an attempt to meet the growing demand. Some idea of the vast quantity of water that has to be made available is shown by the average daily demand made by every man, woman and child in the U.S. It amounts to not less than 110 gallons, and even this figure does not include the vast quantities used or re-used for industrial cooling purposes.

As industries expand and modernize, and as slum clearances proceed, so will water consumption increase; particularly so as irrigation in drier areas is becoming appreciably more recommended. Thus, as would be expected in areas of high rainfall, water is cheap, but as consumption increases, the prices rise.

With this background, it is not surprising that many engineering companies are studying the methods and costs of producing fresh water from sea water. Several different methods of evaporation and distillation, or demineralization have been pursued over the years, but the most economic means of production is still considered to be by thermal processes. More recently, however, different types of plants have been found to be even more economic under certain circumstances.

Thermal Processes

Experiments with flash evaporation processes date back about 25 years. These early investigations showed that the process of heating without boiling does not stop scale formation, which is one of the main practical difficulties in evaporating plant design. Moreover, the use of sprays to feed-in the brine for flashing causes a risk of serious carry-over, giving impure water.

Finally, when the number of stages is the same as the number of effects in a multiple effect thermal submerged tube plant, the heating surface required in the flash plant exceeds that in the thermal plant due to poorer end temperature difference in the heat exchangers.

These three factors mean that flash evaporators are less suitable and more costly than submerged tube plants. It was, however, realized that provided these problems could be solved, the flash evaporation principle would have advantages and for this reason research and development work was started.

Flash evaporation research

A radical change in design was called for, but there were major problems to be overcome. The first of these was capital cost. With the

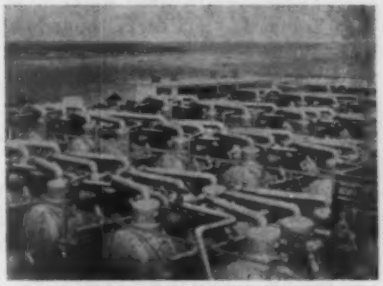


FIG. 1. ISLAND TERRITORY OF Aruba plant. 5 units have a 2.25 mgd output of fresh water.

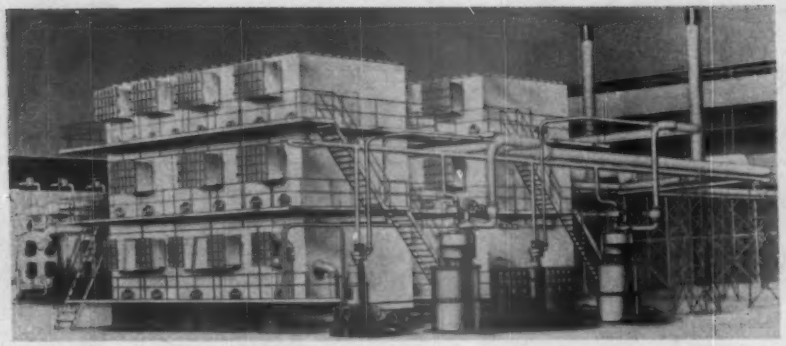


FIG. 2. KUWAIT where two units produce 2 mgd. The Government of Kuwait has had 10 other units operating prior to this installation.

submerged tube plants, the need for low-cost, corrosion-resistant material necessitated the use of cast iron for the main casings of the units. This in turn involved high machinery and shipping costs, because these casings were extremely bulky with relatively low weight.

Secondly, the limit of efficiency in a submerged tube plant was reached with an 8:1 water/steam ratio. However, due to small end temperature difference on the heat exchangers as the number of effects is increased, a ratio of 6:1 was chosen in most cases because the extra efficiency was only obtainable at prohibitive capital costs.

The third problem was that of scale formation in submerged tube plants. This could be successfully overcome by the use of ferric chloride, but still required attention from the viewpoint of running costs for the chemicals required.

A program of design and research development was required to find a practical conclusion for the design of a unit which would successfully overcome these limitations. Three primary requirements would be necessary in the new process; these being to design a plant which could:

1. Be operated at a ratio of 12:1 (*i.e.* 12 lb. of fresh water to be produced for every pound of steam used to heat the sea water).
2. Be fabricated with steel.
3. Be able to run for periods up to 2,000 hours without use of chemicals.

Increasing efficiency

To minimize the restrictions on efficiency imposed by end temperature difference, a plant must be of the "flash" type in which the raw water is heated in tubes under pressure. However, most flash plants use sprays to give a large surface for the interstage flash steam, which in turn requires a heavy expenditure of power to ensure efficiency of the sprays.

It was decided, therefore, to design interstage flow passages in the form of eductors which would create a reduction in pressure during the transfer from one section to the next. This would allow the consequent partial flash to reduce the density of the water entering the next stage, and result in a substantial increase in head. It was realized too that at the same time when the mixture enters the chamber it presents a large surface for the completion of the flash at that stage.

At this point, the velocity is greatly reduced and a gentle ebullition takes place without emitting water droplets. The importance of this action is that the chance of carry-over of impure water as droplets is completely eliminated as the process can at no time become uncontrolled.

A further most important point is that the stages can all be arranged on the same level by virtue of the efficiency of the eductors; in addition, the number of stages can be increased without affecting the performance ratio. What is affected is the end temperature in the heat exchanger, which for a given performance ratio is continually improved as the number of stages increase.

The tremendous importance of this fact is shown in the following examples: In a design for given conditions using four stages to obtain a performance ratio of 3, the heating surface required is 0.138 sq ft per lb/hr of distillate. When eight stages are used, keeping the same performance ratio, the surface needed is only 0.117 sq ft per lb/hr, and with twenty stages, 0.1 sq ft per lb/hr. Thus a saving of 27.5 per cent in the heating surface is possible by a sufficient increase in the number of stages. This large saving enabled the researchers to attain their first objective, *i.e.* a performance ratio of 12:1.

Against this, more chambers were now required for the increased performance ratio, but this did not outweigh the savings which could be made in high-cost tube material provided the unit could be fabricated with steel.

Corrosion control

To attain this second objective, it

Table I
Multiflash Distillation Plants

Location and Operator	No. of Plants	Output of Fresh Water gpd
Curacao, Curacao Petroleum Industries	2	134,400
Curacao, Government Water Works	12	806,400
Aruba, Government Water Works (Fig. 5)	10	672,000
Gibraltar, Government Dockyard	2	134,400
Andaman Island, Government Dockyard	1	67,200
Safaga Bay, Egypt, Egyptian Phosphate Company	1	16,750
Kosseir, Egypt, soc. Egiziana per l'Estrazions ed il Commercio dei Fosfati	1	16,750
Kuwait, the Ruler of Kuwait	10	1,120,000
Aden, British Petroleum Company	3	403,200
Lobitos, Peru, Companie Petrolera Lobitos	2	172,500
Aruba, Executive Council, Island Territory of Aruba (through Singmaster & Breyer, New York)	5	2,240,000
Curacao, Executive Council, Island of Curacao	2	895,000
Bahamas, Preece, Cardew & Rider	2	1,021,000
Kuwait, Government of Kuwait (Fig. 4)	2	2,000,000
Guernsey, State of Guernsey Water Works	1	500,000

was necessary to ensure that adequate de-aeration of the incoming sea water was effected. De-aeration, while removing oxygen from the water and thus preventing corrosion of the steel plate, would also remove dissolved carbon dioxide, thus greatly reducing the rate of scale formation which is the basis of the third objective.

Careful attention was therefore paid to scrubbing incoming feed water before it entered the recirculating circuit and also where the recirculated quantity entered the highest temperature flash chamber. The removal of the gases thus released in these two chambers, and in lesser quantity throughout the remaining chambers, was given much thought in order to ensure the greatest possible efficiency in the de-aeration process.

The accomplishment of the three objectives resulted in the design depicted in simplified form shown on the front cover.

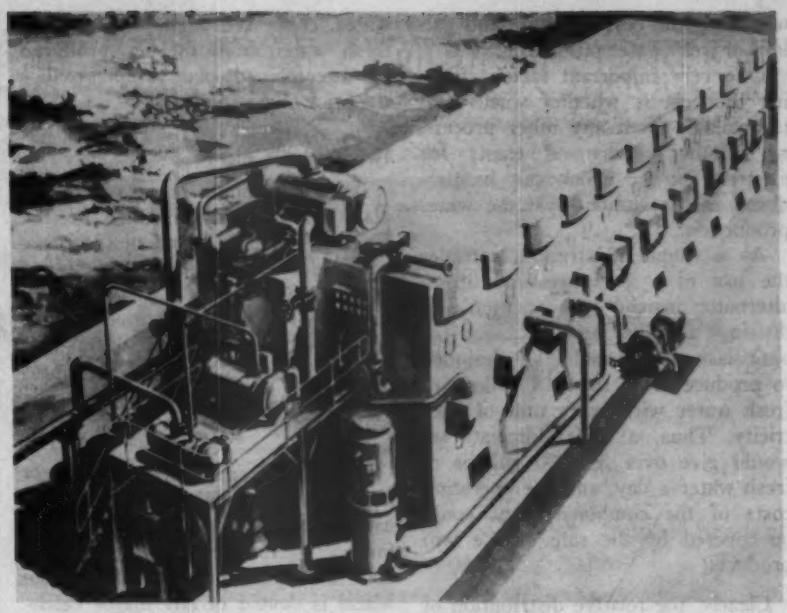


FIG. 4. ARTIST'S IMPRESSION of Island of Guernsey distillation plant designed to produce 0.5 mgd at a cost of about $1.00 per 1,000 gal.

The final design

The sea water is drawn in from the inlet duct by the supply pump and passes consecutively through the three primary heat exchangers fitted at the top of the first three flash chambers. At the outlet header of No. 3 heat exchanger, the sea water has been raised in temperature by the heat from the flashed vapor in these three stages. At this point, a certain quantity is then diverted as plant feed water, treated with scale additive, and enters No. 1 flash chamber. The remainder of the sea water passes to the discharge culvert.

The feed enters No. 1 flash chamber and comes into intimate contact with flashed vapor rising from the brine inflow from No. 2 flash chamber. De-aeration of this incoming raw feed water therefore takes place; the gases released are drawn off by the steam jet air ejector which creates a high vacuum in No. 1 flash chamber and progressively lower degrees of vacuum in the remaining chambers.

The feed water now falls to the bottom of No. 1 flash chamber and combines with the remainder of the brine inflow left after flashing from No. 2 chamber. The mixture is next withdrawn from No. 1 chamber by two pumps, the brine pump and recirculating pump. The brine pump discharges into the outer culvert. The recirculating pump takes by far the larger quantity and discharges this to the inlet header of No. 4 heat exchanger.

The brine now passes consecutively through No. 4 and the remaining heat exchangers and subsequently through the external steam heater. During this passage, it is kept under a pressure exceeding its local boiling point and it gains heat from the condensation of flashed vapor in each chamber (subsequently drawn off as distillate) and from the steam supplied to the external steam heater. The condensate formed in the heater is removed by the heater drain pump and returned to the condensate line leading to the boiler.

The hot pressurized brine leaving the external steam heater now passes through a control valve adjusted in accordance with the required distillate output and enters the final flash chamber where the reduction in pressure causes formation of vapor, besides releasing dissolved gases. The gases are removed via an orifice pipe connected between the final flash chamber and the air ejector suction from No. 1 flash chamber.

The vapor in the final chamber is condensed by the lower temperature brine circulating through the heat exchanger and falls as distillate on to the collecting tray arranged immediately below the bottom tubes. The distillate is then ducted to a similar tray in the penultimate chamber. At the lowest level of the final chamber, the brine is similarly passed to the penultimate chamber over the brine weir where both distillate and the brine partially flash to vapor on entering.

Again condensation and collection takes place and the process is repeated thereafter throughout the remaining stages, the distillate progressively increasing in quantity and the brine progressively decreasing.

With the final collection of distillate in No. 1 flash chamber the total is withdrawn by the distillate pump. Here, advantage is taken of the low temperature and purity of the effluent distillate. It is circulated by a by-pass system to the air ejector and used to condense the high pressure steam to create the necessary vacuum. When the brine has reached No. 1 flash chamber after having passed through all the flash chambers, the recirculation cycle is complete and the process starts all over again.

Cost considerations

It is not possible to give exact figures of cost for any particular location since these depend so much on the local circumstances. The costs of fuel and labor, and the rates at which interest is chargeable on the capital, are the principal factors de-

termining the cost per thousand gallons of fresh water produced.

One very important factor affecting the cost is whether waste heat is available from any other process, or whether a demand exists for electrical power which can be produced in association with the water production.

As a simple illustration, consider the use of a back-pressure turbo-alternator instead of a vacuum-condensing set. In such a case, the multiflash plant could be designed to produce more than 14 gallons of fresh water with every unit of electricity. Thus, a 1,000 kilowatt set would give over 300,000 gallons of fresh water a day, and the operating costs of the combined plant could be covered by the sale of the two products.

Clearly, the relative distribution of the price will depend on the competitive sources of electricity and water. In areas where catchment water costs are high, the sale of fresh water from the sea produced by a combined plant could reduce the price of electricity.

Two-products plant

A good example of a two-product plant was recently installed on the English Channel Island of Guernsey (Figure 4). The plant was designed and installed by G. & J. Weir Ltd. of Glasgow, Scotland, inventors of the "Multiflash" system of distillation. Installations by this firm produce over three-quarters of the world's output by distillation of sea water.

Guernsey is an island of only 24 square miles; population 44,000 who earn their living by flower and truck farming (1,150 acres of greenhouses) and from summer vacationers. The island is devoid of any major catchment basin for conservation of rainfall and the construction of a reservoir was considered impractical and too costly.

A 0.5 mgd "Multiflash" was installed at a cost of $720,000 which included intake pipelines and steam engine driven alternators for generating electrical power. The boilers will produce 21,000 lb/hr of steam at 245 psi, gauge, 3,000 lb to be used by the air ejectors and 18,000 lb for the 550 kw capacity alternator. The steam is exhausted from the alternator through a reducing valve at 30 psi, abs, and is used to maintain the 0.5 mgd fresh water output at a ratio of 11.6:1. This distillate is not to have impurities exceeding 100 mg/L.

The operating cost of this plant is estimated at approximately $1.00/1,000 gal. or $39,000 per year. This figure included with the capital charges based on a 20-year life for the evaporator plant would amount to a total expenditure of about half the cost determined for a reservoir storage scheme of the same capacity.

George W. Hamlin Dies

George Willis Hamlin, age 70, former Water Commissioner of Cleveland, Ohio, died there on August 5, 1960. Mr. Hamlin played a significant professional part in the construction of all four water treatment plants of the City during his 45 years of service in the Department of Public Utilities.

He was first employed by the City as a field engineer during the construction of the Division Avenue Filtration Plant in 1914. Later, he was Engineer of Design and then Engineer of Construction for the 165 mgd Baldwin Filtration Plant built during the early twenties.

Appointed Acting Commissioner of Water and Heat in 1940, he served in this capacity for 13 years and was also Acting Director of Public Utilities for a short period in 1942. The Nottingham Filtration Plant with a capacity of 200 mgd was completed during his tenure as Water Commissioner. In 1953, Mr. Hamlin became Acting Commissioner of Utilities Engineering in which capacity he served until early in 1959. The 50 mgd Crown Plant, dedicated in October, 1958, was completed during this period. Additions to Cleveland's municipally-owned electrical utility system and sewage disposal system were other major projects of his supervision in this position. He retired in July, 1959.

Since joining the American Society of Civil Engineers in 1921, Mr. Hamlin had been President and Director of the Cleveland Section and a member of the committee which drafted the Society's Manual of Engineering Practice No. 19 on Water Treatment Plant Design. He was a member of the National Society of Professional Engineers, the AWWA and the Cleveland Engineering Society.

PSIWA Adopts New Name

The Pennsylvania Sewage and Industrial Wastes Association adopted a new name and elected a new president at the Association's annual conference held at The Pennsylvania State University. Now, officially the Pennsylvania Water Pollution Control Association, the 34 year old group named Alfred A. Estrada to its presidency for the coming year.

Other newly elected offcers are: John Yendhko of Pittsburgh, first Vice-President; Thomas Iezzi of Bristol, second Vice-President; and James R. Harvey of Meadville, re-elected Secretary and Treasurer.

The Association also went on record today in favor of a law for licensing sewage plant operators. The Association believes such a law would be an important step in assuring qualfied personnel for the sewage plants now operating in the State and the many new in the planning stage.

Dr. Mark D. Hollis, president of the Water Pollution Control Federation presented the annual awards at the Association's annual dinner.

George Boone of the Norristown Sewage Treatment Plant received the Hatfield Award for being an outstanding operator in the State of Pennsylvania. The Bodell Award, in recognition for outstanding services to the Association, went to L. D. Matter of Albright and Fieb, Consulting Engineers.

Here we are. I had the plans pigeon-holed until you got here.

RESEARCH PROGRESS REPORT

A research report tells how a capillary viscometer can be used for . . .

Determination of the Flow Parameters of Sludge

by JOHN M. SIRMAN, Senior Student
Civil Engineering School
University of Delaware
Newark, Delaware

EDITOR'S NOTE: The design of pipe lines for carrying sludge is frequently a matter of applying empirical formulations with the hope that the sludge to be pumped is sufficiently similar to the one for which the relation was developed that a workable design will be obtained. This approach is quite satisfactory as long as the pipe line is not particularly long. Short lines are not too critical as any serious misapplication is usually compensated for by some other factor which is overestimated or, what is more frequently the case, the line is sized so large that no problems are encountered. This is the most practical approach since the cost of experiments to determine the size of a short line is not justified. When long lines enter the picture the situation shifts and a more exact design becomes important. The theoretical aspects of sludge flow are somewhat involved since sludge, unlike water, is a non-Newtonian fluid and consequently does not follow the formulae with which we are accustomed to work. In this paper the author develops the basis for work with fluids of this type and presents the basis for a formula which can be applied to sludge flow in pipes. In addition an experimental method is described by which the factors needed to apply this formula to a particular sludge can be determined.

This work was sponsored by a research grant from the U.S.P.H.S.

Introduction

■ MANY LIQUIDS THAT are transported in pipes today cannot be classified as Newtonian fluids. In other words, these liquids do not exhibit a direct proportionality between shear stress and shear rate in laminar flow.

This paper was awarded first prize at the 22nd Annual Student A.S.C.E. Chapter Conference, sponsored by the Central Pa., Del., Lehigh Valley, and Philadelphia Sections, A.S.C.E.

One of these non-Newtonians of particular interest to the field of sanitary engineering is encountered when sludges are transported through pipe lines. Since circumstances may require that these distances be many miles in length, there is ample justification for use of the most rational procedures available for the design of pipelines.

This paper will demonstrate that such rational design techniques are based upon the fundamental hydraulic properties of these sludges, and will further show how these properties may be determined experimentally.

An understanding of non-Newtonian flow properties may best be reached by comparison with Newtonian behavior. The flow curves are expressed by Newton's equation:

$$T = \mu\left(\frac{du}{dy}\right)$$

where T = shear stress

$\left(\frac{du}{dy}\right)$ = shear rate

μ = viscosity of liquid.

Newtonian flow behavior is thus

completely characterized by a single parameter, the viscosity.

In contrast, non-Newtonians are characterized by two flow parameters, as shown by the relationships in Table 1. Bingham plastics differ from Newtonian liquids only in the respect that an initial shear stress is necessary to produce flow. Pseudoplastics are characterized by a power function relationship. More generally, for any non-Newtonian liquid, whose properties are independent of time or duration of shear, the shear stress can be expressed simply as an unknown function of the shear rate.

Although sewage sludge has generally been classed as a Bingham plastic, there is still speculation as to its actual characteristics, and it is even quite possible that it may exhibit Bingham plastic behavior at higher concentrations and pseudoplastic behavior at lower concentrations.[1] Therefore, it would seem desirable to develop flow equations for the sludge based not on a particular non-Newtonian type but on the general relation that shear stress is merely a function of shear rate.

The flow parameters of fluids are determined with a capillary tube or a rotational viscometer, and these parameters are then used for design of pipelines in present day practice; either by a direct scale up from the flow curve, if laminar flow is present, or by obtaining a value of Fanning's friction factor, f, for a given apparent Reynold's Number. The flow parameters of the curve can also be determined and used with the appropriate form of the Hagen-Poiseuille equation for design purposes.

TABLE I

SHEAR STRESS–SHEAR RATE RELATIONSHIPS

NEWTONIAN	$\tau = \mu\left(\frac{du}{dy}\right)$
BINGHAM PLASTIC	$\tau - \tau_y = h\left(\frac{du}{dy}\right)$
PSUEDO-PLASTIC	$\tau = K\left(\frac{du}{dy}\right)^n$
ANY TIME INDEPENDENT FLUID	$\tau = \mu_a\left(-\frac{dv}{dr}\right)$

Theory

To develop a general equation for any time-independent non-Newtonian fluid which does not depend on any particular shear stress—shear rate relation, it is necessary to begin with the general expression for the laminar flow of a fluid in a circular pipe or tube,

$$T = \mu o\left(\frac{dv}{dr}\right).$$

The variables may be separated and the equation simplified if the ratio of shear stress to radius at any point is considered as equal to the ratio of these variables at the wall. The result gives the value for the point velocity,

$$Vi = \frac{\tau_w}{r_w}\int_{ri}^{r_w}\frac{r\,dr}{\mu_a},$$

where Vi = velocity at a given point
τ_w = shear stress at wall
rw = radius at wall
ri = radius at a given point
μ_a = apparent viscosity.

This cannot be integrated directly because μ_a is not known as a function of the radius. However, an expression for the flow rate, Q, in the pipe can be written as

$$Q = \int_0^{r_w} 2\pi ri\ Vi\ dri.$$

Substituting the above value for Vi and carrying out the integration on the right hand side,

$$Q = \frac{\pi\tau_w}{r_w}\int_0^{r_w}\frac{r^3\,dr}{\mu_a}.$$

By changing the independent variable from r to τ and letting

$$X = \frac{Q}{\pi r_w^3}, \quad \text{then}$$

$$X\tau_w^3 = \int_0^{\tau_w}\frac{\tau^3\,d\tau}{\mu o}$$

which differentiates, by the use of Leibniz's rule to

$$\frac{dx}{d\tau_w}\tau_w^3 + 3\tau_w^3 X = \frac{\tau_w^3}{(\mu_a)_w} = -\left(\frac{dv}{dr}\right)_w\tau_w^3.$$

Since $X = \frac{Q}{\pi r_w^3} = \frac{2V}{D}$,

the final result becomes

$$\left(-\frac{dv}{dr}\right)_w = \frac{3}{4}\left(\frac{8V}{D}\right) + \frac{1}{4}\frac{d\left(\frac{V8}{D}\right)}{d(\tau_w)}.$$

This expression for the shear rate at the wall is known as the Rabinowitch-Mooney equation.

Metzner and Reed have modified

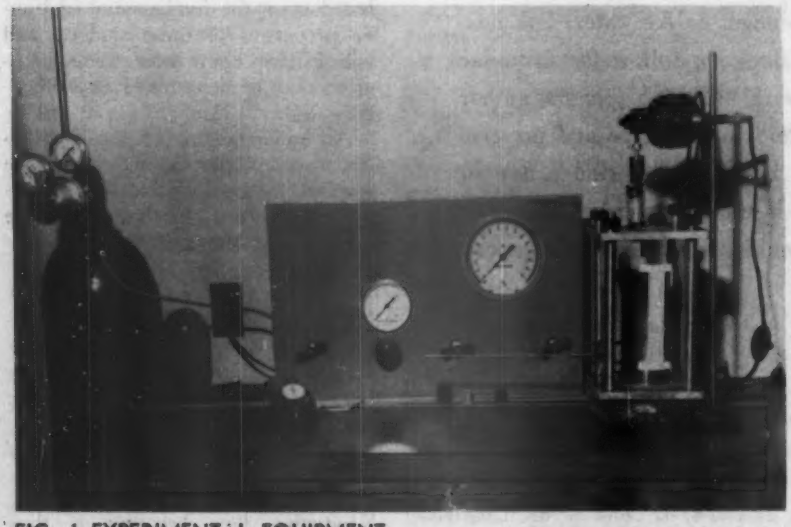


FIG. 1 EXPERIMENTAL EQUIPMENT

this equation by noting that, since

$$\frac{d\left(\frac{8V}{D}\right)}{\frac{8V}{D}} = d\left(\ln \frac{8V}{D}\right) \text{ and}$$

$$\frac{d(\tau_w)}{\tau_w} = d(\ln \tau_w),$$

the equation can be written as

$$\left(-\frac{dv}{dr}\right)_w = \frac{3}{4}\left(\frac{8V}{D}\right) + \frac{1}{4}\frac{8V}{D}\left[\frac{d\left(\ln \frac{8V}{D}\right)}{d(\ln \tau_w)}\right]$$

By letting

$$n' = \frac{d\left(\ln \frac{8V}{D}\right)}{d(\ln \tau_w)},$$

then

$$\left(-\frac{dv}{dr}\right)_w = \left(\frac{3n'+1}{4n'}\right)\frac{8V}{D},$$

the relationship between $\frac{8V}{D}$,

which can be obtained directly from viscometric data, and the shear rate at the wall.

Integrating the expression for n′ gives

$$\tau_w = K'\left(\frac{8V}{D}\right)^{n'},$$

which holds for any time-independent non-Newtonian. K′ can be considered an index of the consistency of the fluid, and n′ a characteristic of the extent of non-Newtonian behavior. When n′ equals one, the expression reverts to that for a Newtonian fluid, and K′ is the viscosity of the fluid.

A generalized Reynold's Number for all time-independent fluids can now be obtained by combining

$$\tau_w = K'\left(\frac{8V}{D}\right)^{n'},$$

where

$$\tau_w = \frac{D\Delta P}{4L}$$

which can be shown by making a force balance on a segment of flow in pipe; the Fanning friction factor,

$$f = \frac{D\Delta P}{4L} \Big/ \frac{pV^2}{2g},$$

where

- D inside diameter of pipe
- ΔP pressure drop along length, L, of pipe
- P density of liquid
- V mean velocity of flow in pipe
- g acceleration due to gravity;

and the standard Newtonian relationship between the Fanning friction factor and Reynold's Number in laminar flow,

$$f = 16/N_{RE}.$$

The result is

$$N_{RE} = \frac{D^{n'}V^{2-n'}}{K'8^{n'-1}}P,$$

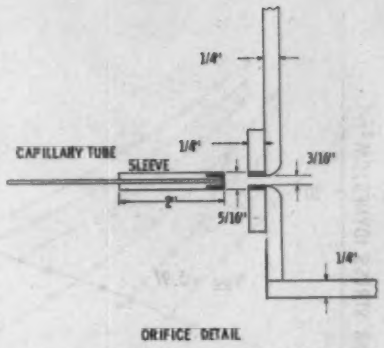
which can be used to predict the region of transition from laminar to turbulent flow, which usually occurs at $N_{RE} = 2100$.

Experimental Apparatus

A capillary tube viscometer consists essentially of a pressure cylinder, an accurate method of applying and measuring pressure, and a calibrated tube through which the sample is forced.

One of the first problems to consider when designing such a viscometer for use with sewage sludge is that of settling of the particles. Obviously, to prevent this the sample will have to be agitated in some manner while in the test cylinder. For the design used in this case, a stirring rod was built into the cylinder through a pressure-tight bushing that would take pressures well above the maximum used. This stirring rod was then driven during the test by a two-speed Fischer lab-motor. Actually it was necessary to use two different sized paddles on the rod, depending upon the solids concentration of the sample so that excessive agitation could be reduced, and yet still keep the sample completely mixed.

The test cylinder was made of a 10 in. length of lucite cylinder which was six inches nominal diameter with one-quarter inch walls.



ORIFICE DETAIL

FIG. 2. DETAILS OF THE ORIFICE

A bottom of one-quarter inch sheet lucite was glued on. The top was made of one-half inch aluminum plate seven and one-half inches square. The top of the cylinder was recessed into the top plate one-quarter inch and the seal was made with a neophrene rubber gasket. The top aluminum plate was held down by four vertical rods anchored into a similar plate at the bottom, as shown in Fig 1. The stirring rod and the pressure tap were inserted through the top.

An orifice (Fig. 2) was made in the side of the cylinder 1.5 in. up from the bottom of the cylinder. A three-sixteenths inch hole was cut completely through the cylinder and was counterbored on the inside of the cylinder to a reverse radius of approximately three-sixteenths inch, to reduce entrance losses due to a sudden contraction. A one-quarter inch lucite disc 2 in. in diameter was glued to the outside of the cylinder over the orifice and threaded with a five-sixteenths inch tap to accommodate the sleeve on the capillary tube.

The capillary tubes used were seamless, stainless steel tubes. Two nominal inside diameters were used, one-eighth inch, and one-sixteenth inch, and there were three different lengths for each diameter—one foot, three feet, and five feet. To mount the tubes in a horizontal position to the test cylinder, a two inch long, five-sixteenths inch diameter brass sleeve was welded onto the end of each tube and threaded, so that the tube could simply be screwed into place when used.

Pressurized nitrogen was chosen as a means of applying pressure to the cylinder. The gas pressure from the bottle was regulated in the line

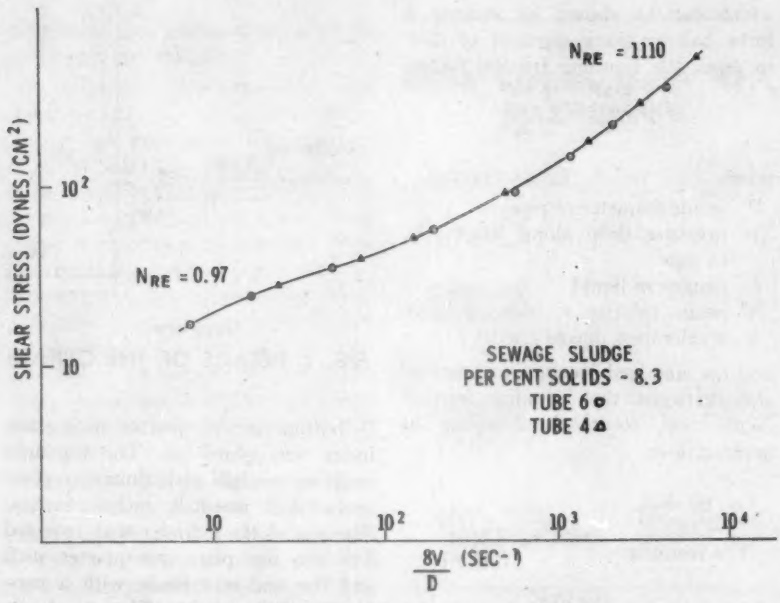


FIG. 3. EXPERIMENTAL RESULTS with 8.3 per cent sludge.

by a 0-15 psi regulator and the pressure indicated by a 6 in. laboratory test gage graduated and calibrated to 0.05 psi. The pressure line was attached to the test cylinder by means of a quick-couple assembly that simply snapped into place when a sample was ready to be run.

Experimental Procedure

The samples of sludge used were prepared from a single batch of digested sewage sludge from the sewage treatment plant at Wilmington, Delaware. The sludge was placed under vacuum for at least twenty-four hours to remove the majority of gases that might have been present. Nine samples were prepared by diluting the original material so that the solids concentration ranged from 2.8 per cent to 10.5 per cent by weight.

Because of occasional inert particles in the samples which were larger even than the inside diameter of the largest tube, it was necessary to strain the sludge. This was accomplished with a soil sieve with 0.20 centimeter openings. The percentage of solid material removed by the sieve was insignificant.

Having prepared the samples for testing, it was necessary to calibrate the capillary tubes to be used. The lengths could be satisfactorily measured with a scale. However, this method was practically impossible for determining the inside diameters of the tubes. Therefore, the tube diameters were calibrated with distilled water, which has a known viscosity and density at a specified temperature, by solving for D in the Hagen-Poiseulle equation for laminar flow of Newtonian liquids.

The temperature for all experiments was controlled by performing the tests in a constant temperature room, which remained at 20°C (± 1°C). Therefore, all equipment was maintained at 20°C and the samples were left in the constant temperature room long enough to be at that temperature before the test was run.

The data needed to determine the values of τ_w and $\frac{8V}{D}$ for a logarithmic plot of τ_w versus $\frac{8V}{D}$, is

D —diameter of tube, cm.,
L —length of tube, cm.,
P —density of sample, gm./cu. cm.,
ΔP —the pressure in dynes/sq. cm. at the tube inlet minus that at the outlet (actually the pressure applied to the cylinder),
Z_1 and Z_2 —the static head at beginning and end of the run, respectively, cm.,
T —time of flow in tube, sec.,
W —weight of sample that flows through the tube, cm. A force balance on a segment of fluid within the pipe shows that

$$\tau_w = \frac{D\Delta P}{4L}.$$

Therefore, the shear stress for various rates of flow is easily obtained from the viscometric data. The corresponding value of $\frac{8V}{D}$ is also obtained by using the data, observing that

$$\frac{8V}{D} = \frac{8Q}{DA} = \frac{32W}{P\pi D^2 T}.$$

Usually nine or ten points, corresponding to pressures from 0.20 psi to the maximum 15 psi, plotted on logarithmic coordinates are enough to adequately describe the flow curve for a given sample.

Design Procedure

Having obtained the flow curve for a sample, the design of pipes to carry a sludge with the same solids concentration and at the same temperature can be made by a scale-up from the curve plotted on logarithmic coordinates as shown in Fig 3.[2] For such a scale-up, it is well to have a curve determined from data from two different length tubes. This reduces the influence of possible time dependency of the sludge and inevitable errors in obtaining data. The data for a five foot tube and a three foot tube agree very well, as can be seen in Fig 3.

However, since it is usually necessary to determine the apparent Reynold's Number for given points on a curve in order to locate the region of transition from laminar to turbulent flow, pipeline design is also practical using the relationships between Reynold's Number and Fanning's friction factor shown in the theoretical discussion for laminar flow.[3] In the turbulent range, emperical relationships between N_{RE} and f for non-Newtonians are available.

Reynold's Number is a function the flow parameters k′ and n′; therefore it is necessary to determine these parameters to compute N_{RE} Referring to Fig 4, it is obvious that n′ is the slope of the curve

at given values of $\frac{D\Delta P}{4L}$ and $\frac{8V}{D}$, and k′ equals the intersection of the ordinate by the tangent n′ at a value of $\frac{8V}{D} = 1$.

It was also shown in the theoretical section that the shear rate at the wall is given by

$$\left(-\frac{dv}{dr}\right)_w = \left(\frac{3n' + 1}{4n'}\right)\frac{8V}{D}$$

Therefore, having determined the flow parameter n′, $\frac{8V}{D}$ can be converted to the shear rate at the wall. This gives paired values of shear stress and shear rate.

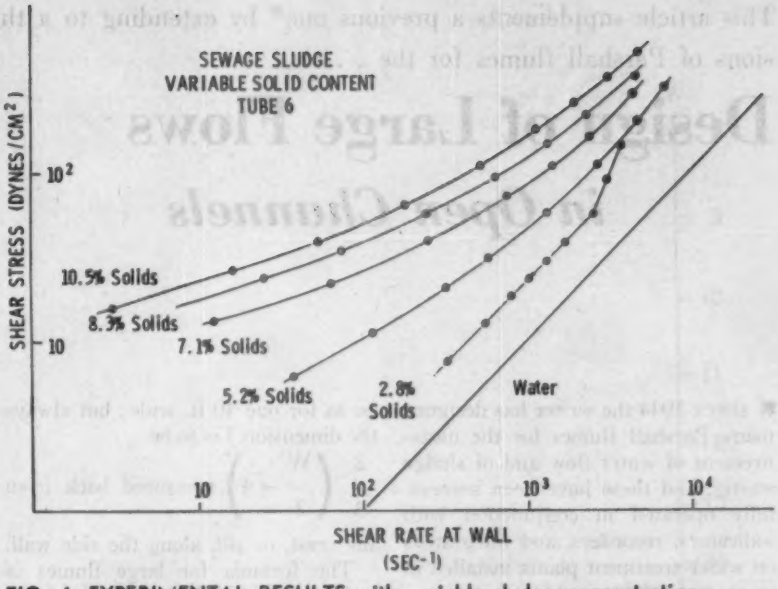


FIG. 4. EXPERIMENTAL RESULTS with variable sludge concentration.

Results

The results depicted in Fig 5 clearly illustrate that solids concentration is a very important parameter of sludge flow. The degree of departure from Newtonian flow, with a slope of unity, increases with increasing concentrations and decreasing flow rates for concentrations of 5.2 per cent through 10.5 per cent. However, the 2.8 per cent concentration has a slope of unity in laminar flow, which indicates Newtonian properties. Its displacement from the curve for water is the result of its having a larger viscosity than water. These results confirm the experience of previous investigators in that sludges whose solids concentrations are low behave similarly to water.

Rational design of pipelines to carry sludges is possible when the range of concentration is known, and basic experimental data are available to determine flow parameters. The equipment which has been described in this report is considered satisfactory for the collection of such data.

Summary

A capillary viscometer has been utilized to obtain viscometric data for sewage sludge, whose solids concentration ranges from 2.8 to 10.5 per cent. The tubes used with the viscometer were smooth, stainless steel ones of two diameters, nominally one-eighth inch and one-sixteenth inch. No attempt was made to investigate pipe roughness.

The flow curves obtained from the data were plotted as shear stress versus $\frac{8V}{D}$, and clearly indicated that increase of solids concentration increased the degree of non-Newtonian behavior.

Methods were presented by which the design of larger smooth pipes can be made from the flow curves developed from the viscometric data.

It seems reasonable to conclude that this method of determining a flow curve with a capillary viscometer to be used for pipeline design is a valid method, and could be applied in preference to the more empirical methods now in use.

References

1. *Derivation of Flow Equations for Sewage Sludges*, by Behn, V. C., Report No. w5, Civil Engineering Department, Engineering Experiment Station, University of Delaware Newark, Delaware, August, 1959.
2. *Pipeline Design for Non-Newtonians*, by Alves, G. E., D. F. Boucher, and R. L. Pigford, Chemical Engineering Progress, Vol. 48, No. 8, pp. 385-393, (1952).
c. *Non-Newtonian Technology*, A chapter by Metzner, A. B., in *Advances in Chemical Engineering*, Edited by T. B. Drew, and J. W. Hoopes, Academic Press, Inc., New York, 1956.

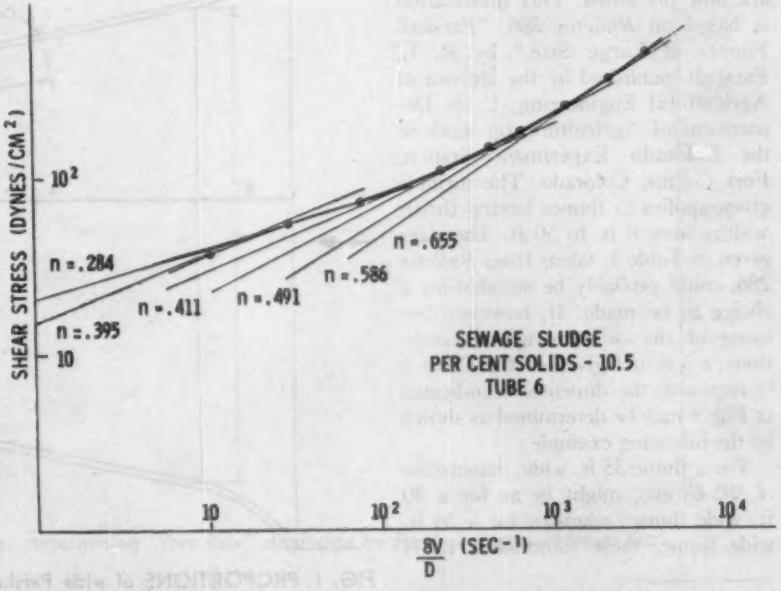


FIG. 5. EXPERIMENTAL RESULTS with 10.5 per cent sludge.

This article supplements a previous one* by extending to a throat width of 50 ft. the dimensions of Parshall flumes for the . . .

Design of Large Flows
in Open Channels

by J. TARRANT
Ruislip, England

■ SINCE 1944 the writer has designed many Parshall flumes for the measurement of water flow and of sludge wastes, and these have been successfully operated in conjunction with indicators, recorders, and integrators on water treatment plants installed in many parts of the world.

The advantages of this type of flume, as compared with weirs, in reduced head loss, freedom from silting, and, in some installations, reduced pumping costs, have been amply demonstrated. Also, the accuracy of measurement with carefully constructed flumes has been shown, by volumetric comparison with flow indicators, to be within the usually accepted limits applied to weir flow.

In some of the installations referred to, it was necessary to provide flumes larger than those covered by the information in the earlier article.* Therefore, data for the design of flumes larger than 96 in. throat width are now presented. This information is based on *Bulletin* 386, "Parshall Flumes of Large Size," by R. L. Parshall, published by the Bureau of Agricultural Engineering, U. S. Department of Agriculture, on work at the Colorado Experiment Station, Fort Collins, Colorado. The formula given applies to flumes having throat widths from 8 ft. to 50 ft. The sizes given in Table 1, taken from *Bulletin* 286, could probably be suitable for a choice to be made. If, however, because of site or construction conditions, a size not given in the Table 1 is required, the dimensions indicated in Fig. 1 may be determined as shown by the following example:

For a flume 35 ft. wide, dimensions *A, B, C,* etc., might be as for a 30 ft. wide flume; whereas, for a 38 ft. wide flume, these dimensions could be as for one 40 ft. wide; but always the dimension J is to be

$$\frac{2}{3}\left(\frac{W}{2}+4\right)$$

measured back from the crest, or sill, along the side wall.

The formula for large flumes is

$$Q = (3.6875W + 2.5)\ H_A^{1.6}$$

Q is the discharge, in cubic feet per second; W is the width of throat, in feet; and H_A is the head on the crest, or sill, in feet.

As in the previous article, the formula applies to "free flow" conditions; that is, the downstream head must not be allowed to reach a level at which the single head reading would become inaccurate. For these large flumes, the limiting submerged flow is 80 per cent, which means that the level downstream of the flume must be such that the loss of head through the flume (the difference between the upstream and downstream water levels) must be not less than 20 per cent of the measured head H_A. It is

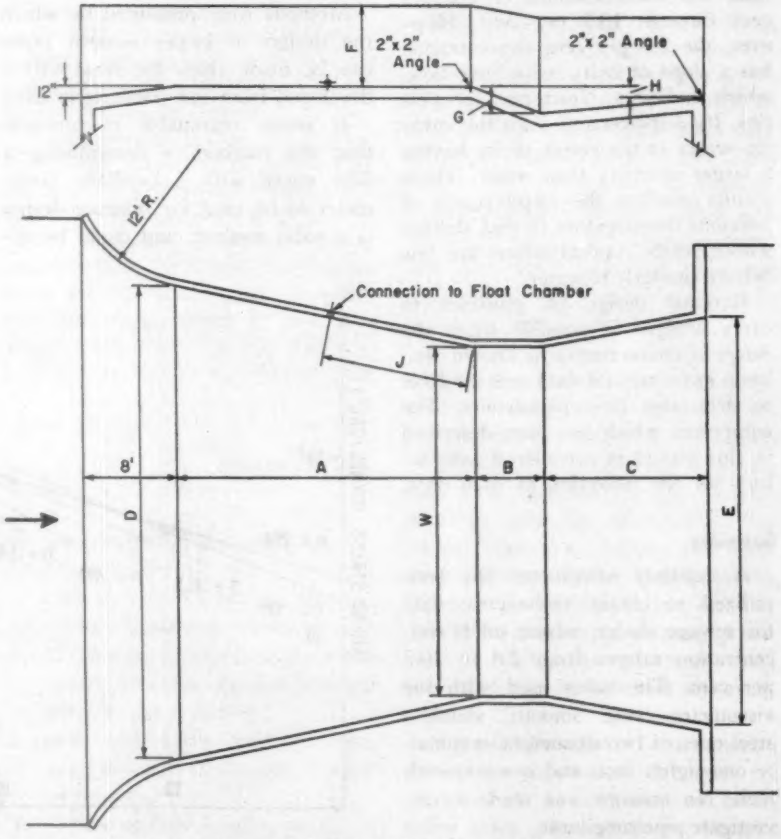


FIG. 1. PROPORTIONS of wide Parshall flumes for flow measurements in open channels.

*Water Works and Sewerage, Sept. 1944, p. 328.

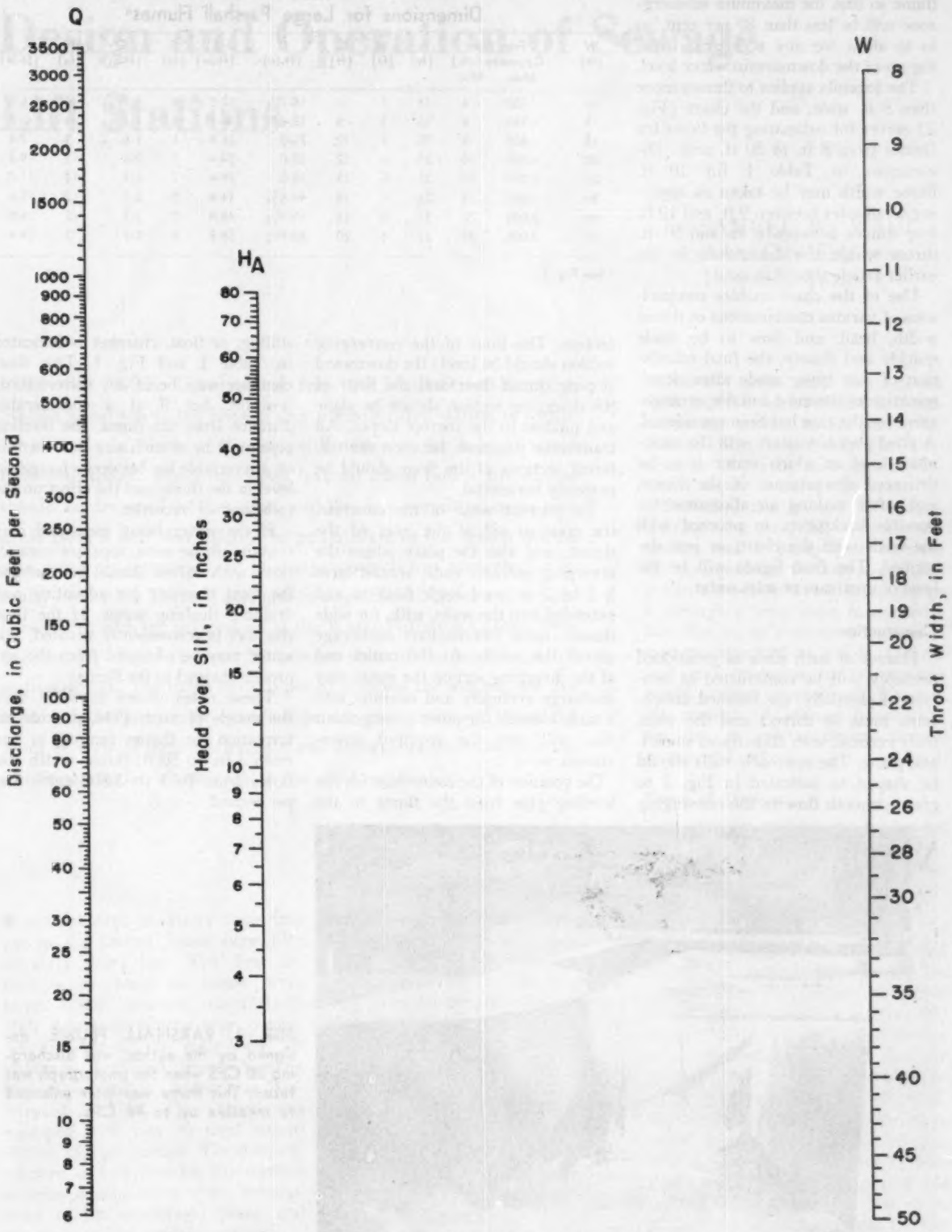


FIG. 2. NOMOGRAPH for determining "free flow" discharge by Parshall flumes of large size.

advisable to arrange the siting of the flume so that the maximum submergence will be less than 80 per cent, so as to allow for any accidental backing up of the downstream water level.

The formula applies to flumes more than 8 ft. wide, and the chart (Fig. 2) serves for estimating the flows for flumes from 8 ft. to 50 ft. wide. Dimensions in Table 1 for 10 ft. flume width may be taken as applying to all sizes between 9 ft. and 10 ft. For flumes between 8 ft. and 9 ft. throat width, the dimensions in the earlier article should be used.

Use of the chart enables comparisons of various combinations of throat width, head, and flow to be made quickly and closely, the final calculation of size being made after determination of the most suitable arrangement for the case has been considered. A good plan is to start with the maximum level at which water is to be delivered downstream of the flume, and, after making an allowance for possible backingup, to proceed with the trials with the chart, as just described. The final figure will be the level of upstream or inlet water.

Table 1
Dimensions for Large Parshall Flumes[a]

W (ft)	Free Flow Capacity (cfs) Max.	Min.	A (ft)	B (ft)	C (ft)	D (ft-in)	E (ft-in)	F (ft)	G (ft-in)	H (in)	J (ft-in)
10	200	6	14	3	6	15-7 1/4	12-0	4	1-1 1/2	6	6-0
12	350	8	16	3	8	18-4 3/4	14-8	5	1-1 1/2	6	6-8
15	600	8	25	4	10	25-0	18-4	6	1-6	9	7-8
20	1,000	10	25	6	12	30-0	24-4	7	2-3	12	9-4
25	1,200	15	25	6	13	35-0	29-4	7	2-3	12	11-0
30	1,500	15	26	6	14	40-4 3/4	34-8	7	2-3	12	12-8
40	2,000	20	27	6	16	50-9 1/2	45-4	7	2-3	12	16-0
50	3,000	25	27	6	20	60-9 1/2	56-8	7	2-3	12	19-4

[a] See Fig. 1.

Construction

Flumes of such sizes as mentioned probably will be constructed of concrete. Essentially, the finished dimensions must be correct and the walls truly vertical, with all surfaces smooth and plane. The approach walls should be shaped as indicated in Fig. 1 to give a smooth flow to the converging section. The floor of the converging section should be level; the downward sloping throat floor and the floor of the diverging section should be plane and pitched to the correct slopes. All transverse junctions between the different sections of the floor should be perfectly horizontal.

To prevent wear of the concrete, the crest or sill at the inlet of the throat, and also the place where the diverging sections ends, should have a 2 by 2 in. steel angle built in and extended into the walls, with, for wide flumes, some intermediate anchorage across the width. At the outlet end of the diverging section the water may discharge vertically and laterally into a tank, channel, or other arrangement that will give the required downstream level.

The position of the connection for the leveling pipe from the flume to the stilling, or float, chamber is indicated in Table 1 and Fig. 1. This float chamber may be in any conventional position, but if at a considerable distance from the flume, the leveling pipe must be of such size that there is no appreciable lag between changes in level in the flume and the effect on the indicator or recorder.

If the water being measured may contain silt or sand, separate connections with valves should be made to the float chamber for admitting and draining flushing water. If the float chamber is conveniently situated, this water may be obtained from the approach channel to the flume.

These notes, taken together with the article of Sept. 1944, provide information for flumes ranging in size from 3 in. to 50 ft. throat width and flows from 0.03 to 3,500 cubic feet per second.

FIG. 3. PARSHALL FLUME, designed by the author, was discharging 20 CFS when the photograph was taken. This flume was later enlarged to measure up to 46 CFS.

Some basic considerations are reviewed in the . . .

Design and Operation of Sewage Lift Stations

by SAMUEL W. WAHL
Asst. City Engineer
Lubbock, Texas

EDITOR'S NOTE: Development from the Ward Street Pumping Station in Boston to the present day prefabricated station is within the memory of many of the men still active in the field of waste treatment today. Much has been learned about how a lift station should be designed in that time, and this has permitted us to progress from a unit that filled a large building to one which can be completely underground. In this paper, which was presented originally before the Texas Water and Sewage Short School and is published here with the permission of the Water Pollution Control Federation, Mr. Wahl reviews the present state of the science of lift station design. The three basic types of stations, the wet pit, the dry type and the pneumatic-ejector type are each reviewed from the point of view of their advantages and disadvantages as well as the conditions under which each is the most applicable.

■ SEWAGE LIFT STATIONS came into use in the United States some fifty to sixty years ago. The first lift stations or pumping plants were large, steam powered installations with enormous plunger-type pumps. An example of the early type lift station is the Ward Street Pumping Station in Boston, which was constructed in 1904. The station was equipped with two 50 mgd steam-driven, plunger pumps. The compact, efficient and dependable lift stations of today are the result of the development of the centrifugal pump and the wide use of electric motors.

Need for Lift Stations

In the expansion of sewer systems, it is sometimes necessary to use lift stations. Sometimes the area to be served lies at an elevation which is too low to permit the use of gravity flow lines; sometimes the area lies beyond existing trunk lines. An investigation is made to determine the boundries of the area to be served by the lift station. Within the scope of this investigation is the determination of the probable initial quantities to be pumped, the probable future quantities, and the maximum ultimate quantities that the station will be required to pump.

Every effort should be made to avoid the use of lift stations by using gravity lines wherever possible. Initial cost, operational expense, replacement costs, and maintenance costs, together with reduced land valuation attributable to lift station locations, oftentimes favor the construction of gravity flow lines at sufficient depth to serve the area.

Basically, the sewage lift station consists of a wet well to retain the sewage and a pump that removes the sewage from the sump and lifts it into a manhole elevation or pumps it through a force main to a gravity flow line or to a treatment plant. If sewage contained no solids, the design and operation of lift stations would present no problems. The solids content of sewage necessitates the use of special design pumps, sumps, and controls.

Types of Stations

Sewage lift stations can be divided into three types: the wet-pit type, the dry-pit type, and pneumatic-ejector type. Each type of station is suitable for a particular installation.

The wet-pit lift station consists of a wet well in which are installed submersible pumps. The pumps are driven either by motors mounted above the wet well or by submersible motors in the wet well. The motors are controlled by either a float or pressure device. If submersible or explosion-proof motors are used, the entire installation can be made below ground. The wet-pit lift station is relatively inexpensive to construct, but the disadvantages of this type lift station are many. The entire pump must be removed from the wet well for servicing; therefore, special hoisting equipment must be available when a stoppage occurs. Thus the station is inoperative for long periods

of time and requires the use of standby equipment to handle the flow while the stoppage is being cleared. The use of a wet-pit lift station is recommended only when sufficient funds are not available to construct a dry-pit or pneumatic-ejector lift station.

The dry-pit lift station consists of a wet well to retain the sewage and an adjacent dry pit which houses the pumps, motors and controls. The motor control may be either a float or pressure device. The motors and controls may be either in the dry pit itself or in a superstructure above the dry pit. In installations where there is danger of occasional flooding of the dry pit, the motors are mounted above the dry pit and the pumps are connected to the motors by long drive shafts.

The pneumatic-ejector lift station is a combination of the wet-pit and the dry-pit types in that the wet well is located in the dry pit and is a part of the pumping unit. The pneumatic-ejector lift station is a very dependable installation and it is completely odorless. The disadvantages of using this type of lift station are the high initial installation cost and its low operating efficiency.

The three types of lift stations mentioned are available, with various modifications, from prefabricators of sewage pumping stations. These lift stations are furnished complete except for the wet well, which is constructed on site. The prefabricated lift station is especially suitable for serving new subdivisions lying outside of areas served by existing trunk mains. As the area is developed and trunk mains are constructed, the prefabricated lift station can be moved to a new location with very little additional expense.

Station Design

The wet well of a conventional lift station, whether it is a wet-pit or dry-pit type installation, serves as a sump for the pumps. The size of the wet well is determined by the quantity of sewage, the variation of flow, and size and number of pumps. The capacity of the wet well should be large enough to prevent the constant starting and stopping of the pumps during high flow periods, and small enough that sewage is stored no longer than ten or fifteen minutes. Sewage stored in wet wells tends to become septic with resulting odor problems. Long retention time permits the solids to settle out and form a sludge cake on the floor; therefore, the floors of the wet well should slope toward the pump intake at a steep slope to aid the solids toward the pump intake and to help prevent the formation of a sludge cake on the floor.

The use of screens in a wet well is debatable. A screen will protect the pumps against clogging but the screenings at a lift station present a disposal problem and storing them for any length of time causes an odor problem. One solution to the problem is the use of comminutors if the sewage contains many solids or solids of such size that the pumps clog frequently.

The two types of pumps in lift stations are centrifugal and plunger pumps. Plunger pumps are seldom used in lift stations today, but vertically mounted centrifugal pumps are used extensively. Centrifugal pumps with a four inch suction and discharge, which will normally pass solids up to three inches in diameter, should be the smallest pumps used. A wide variety of impeller designs are available, the choice of which is determined by the composition of the sewage to be pumped. The size and number of pumps depends upon the amount of sewage flow. The number of pumps should be sufficient to handle the greatest flow anticipated when the largest pump is out of service.

The pumping unit in a pneumatic ejector consists of a receiver for the sewage and an air compressor to supply the compressed air necessary to eject the sewage from the receiver. The pneumatic ejector has few moving parts in the receiver. The need for screening is eliminated because the ejector will handle anything that will pass through the sewer line.

Power and Controls

Electric motors provide the most satisfactory power for the pumps. Standby generating units should be provided for lift stations that are located in the watershed or water supply lakes. In any case, it is desirable to have electric power available from two different circuits. In lift stations where the flow is relatively uniform, variable-speed motors can be used to operate the pumps at a rate to match the flow.

The control system of the lift station controls the starting and stopping of the pumps. The float control system uses a float to trip a switch at a predetermined level, or allows a tape to rotate a mercury switch which starts or stops the pumps. The floats are enclosed in a tube which is connected to the wet well. The pressure system uses a pressure switch to start or stop the motors.

Various accessories such as dehumidifiers, forced-air blowers, and remote control systems are incorporated into lift stations when required. Forced-air ventilation is necessary whenever there is danger of the accumulation of poisonous or explosive gas.

Successful operation of the sewage lift station is dependent upon the station being built to the particular requirements of that station and upon proper maintenance of the equipment used.

Data Compiled On The Uses of Water

Fourteen Federal agencies' programs for the collection of data on the uses of water are listed in the lately issued publication, "Federal Programs for Collection of Data on Water Use, Bulletin No. 10," announced by the Division of Water Supply and Pollution Control of the Public Health Service.

The bulletin was prepared under the auspices of the Inter-Agency Committee on Water Resources, Subcommittee on Hydrology, and compiled for publication by the PHS. For ready reference, the bulletin lists, by category of water use, schedules and scope of data and miscellaneous details. These categories include: rural domestic, public water supplies, agriculture, manufacturing and mineral industries, hydro and thermo power, navigation, pollution abatement, recreation, fish and wildlife, and Federal installations.

The publication is for sale by the Superintendent of Documents, U. S. Government Printing Office, Washington 25, D. C., at 35c a copy.

Continuous record of never restricting water use is assured as . . .

Shenango Valley Water Company Expands Its Plant

by WILLIAM S. LINK, Supt.
Shenango Valley Water Co.
Sharon, Pennsylvania

EDITOR'S NOTE: The privately-owned water companies continue to improve their water systems. At Sharon, the Shenango Valley Water Company has increased plant capacity, included automatic controls, reduced chemical handling costs, provided for emergencies and for future expansion. The Company has never restricted water consumption and is now, after investing $2.5 million, in a good position to continue this record.

■ THE SHENANGO Valley Water Company of Sharon, Pennsylvania, has a well-earned reputation for not having imposed water restrictions on its customers. In today's rapid industrial expansion and home building boom, this kind of service can be maintained only by long range planning to keep pace with community growth. The company serves 15,548 customers in the cities of Sharon, Farrell, the Borough of Wheatland, Hickory Township in Western Pennsylvania and Masury and Brookfield Townships in Ohio.

Expansion Program

Early in 1956 it was obvious that the company would have to expand its facilities. Scorning any halfway measures of "let's do what we have to do to catch up to the demand . . ." the company entered into what was to be the greatest expansion and improvement program in its history.

First, Malcolm Pirnie Engineers were engaged to study the plant and the distribution system. In June, 1957, they submitted a comprehensive report recommending expansion and improvement of both the plant and the system of transmission mains which carry water away from the plant to the distribution system. Two phases of construction were set up, the first consisting of new sedimentation basins and pre-treatment facilities. Then, the old basins would be demolished to make way for the filters and clearwell of the second phase.

Various factors influenced the arrangement of the additions. These were the topography, the physical condition of existing structures, and the arrangement of the two parallel treatment plants already in operation.

The entire 2½ million dollar program was completed by April of 1960 and is now in full operation.

The major improvements and additions consist of the following:

New raw water pump capable of lifting 10 mgd from the Shenango River.

New flash mix equipment for a quicker and more thorough treatment of raw water.

Two new flocculators to assist in purifying more water more quickly.

Two new sedimentation basins which have more than doubled capacity to purify water.

Automatic sludge removal equipment that keeps basins in operation longer with far less maintenance.

New high service pump capable of pumping 9 mgd to the distribution system.

New filters capable of producing an added 6 mgd.

New clearwell holding 500,000 gallons of pure water in reserve.

More than four miles of transmission mains.

New Chemical Head House

The first floor of the new chemical head house contains chemical dosage equipment consisting of two universal* volumetric dry chemical feeders and one Rotodip* feeder. The dry chemical feeders are being used to feed lime and soda ash into the sedimentation basins and the new clear-well, respectively. The new Rotodip Feeder applies liquid alum to the two flash mixers. Flash mixing tanks and use of liquid alum are two new features included in this water treatment plant expansion.

Also located on the first floor is a new chlorination room which houses two new Fischer-Porter chlorinators of 100 and 1,000 lb per day capacities and two Wallace and Tiernan chlorinators of 750 and 500 lb per day capacities. Three points of chlorination application are provided under the new operational design. These are—to the raw water previous to the flash mixers—before filtration—and filtered water in the clearwell. Past operation has provided pre-chlorination to the raw

*Products of Omega Machine Co., Providence, R.I.

water, but under new plant design it will be possible to chlorinate after sedimentation and realize savings in chlorine costs. The two flash mixing tank motors are installed on the operating floor and telescopic valves for removal of sludge from the two sedimentation tanks in the sludge control tank are also operated from the operating floor level. These telescopic valves are being operated manually every hour for sludge removal.

The basement of the new chemical head house provides storage for liquid alum in two 10,500 gallon tanks, two liquid alum recirculation pumps, storage for one ton chlorine containers, two chlorine container platform scales, two flash mixing tanks, and a sludge control tank.

Mixing And Clarification

The two reinforced concrete flash mixing tanks each have a capacity of 6,500 gallons. One flash mixing basin provides a mixing time of about 1.2 min. at 8 mgd rate, the design rate for the new flocculators and sedimentation basins. The second flash mixer has been installed and will be used in conjunction with future flocculation and sedimentation basins.

After a flash mix with alum and chlorine, the raw water flows into duplicate flocculation basins equipped with Stewart-Carter Walking Beam Flocculators for slow mixing. The total capacity of the flocculation basins is 215,000 gallons providing 39 mins. detention time at 8 mgd.

Sedimentation is provided in duplicate reinforced concrete basins, each 55′ x 123′, having a total capacity of 1,255,000 gallons and a detention time of 3.8 hrs. Process Engineering continuous rotary sludge removal scrapers are installed in the first 55 feet of each basin. The effluent troughs are constructed of reinforced concrete with submerged circular outlet ports.

A new 42 in. reinforced concrete line carries settled water from the new sedimentation basins to the existing 5.1 mgd south filter plant and to the new 6.2 mgd filter plant extension.

Filtration

The new filter plant extension houses four 1.55 mgd rapid sand filters with clearwell storage underneath. The clearwell extends past the new filter plant superstructure and is designed to permit future addition of four 1.55 mgd filters.

This additional 6.2 mgd filtration capacity provides a total South Plant filter capacity of 11.3 mgd. With the 3.1 mgd in the existing North Filter Plant, the total plant filter capacity is 14.4 mgd.

The new clearwell has a capacity of approximately 590,000 gallons. The old clearwell, under and adjacent to the North Plant filters has a capacity of 210,000 gallons, for a total clear well storage of 800,000 gallons.

SHENANGO VALLEY WATER COMPANY'S new chemical head house as seen across the sedimentation basin.

Since the flow line of the new filters is approximately 4.5 ft higher than the existing South Plant filters, a 16 in. pneumatically operated throttling butterfly valve is used to maintain maximum water elevation at the old South Plant Filters and prevent overflowing.

The four new 1.55 mgd filters are equipped with hydraulic-pneumatic butterfly valves, rate setters, flow rate and head loss recorders and indicators, filter surface sweeps, and porcelain sphere underdrains. Laminated plastic washwater troughs were installed. The washwater flow metering equipment consists of a Venturi tube with integral hydraulically-operated butterfly valve, telemeter transmitter, totalizer recorder and 24 in. circular indicating gage.

Each 12 in. filter effluent line contains a rate of flow controller of the Venturi tube type with integral hydraulically-operated butterfly valve. Each filter controller starts to close as the clear well approaches its 11 ft maximum water elevation. This is accomplished by means of a float actuated pneumatic transmitter, and a pneumatic selector relay on each filter effluent controller. This equipment automatically overrides each manual filter rate setter causing the filter controllers to shut off.

Maximum water elevations are maintained in the new sedimentation basins and the North Plant sedimentation basins by float-controlled pneumatic-hydraulic operated 24 in. and 16 in. butterfly valves. The 24 in. valve is installed in the new 36 in. reinforced concrete raw water line and the other on the 16 in. line from the new flash mixers to the North Sedimentation Basins. The 24 in. butterfly valve actually throttles the raw water pumps and shuts completely when the new sedimentation basins are full.

Flocculators And Flow Meters

Also installed during plant expansion were Walking Beam* flocculators in the North Settling Basins, a new mgd high service pump, a 10.0 mgd raw water pump, a 30 in. reinforced concrete plant effluent line replacing old piping. One 16 in. Venturi meter was replaced with a new 24 in. Dall-Flow Tube** which includes a telemeter transmitter and and a totalizing, indicating and recording receiver. An existing 24 in. Venturi meter on the plant discharge piping was removed and installed in a new location in the plant effluent piping.

Raw water had never been metered at this plant. A new 24 in. flow tube was installed on the new 36 in. reinforced concrete raw water line. This flow meter and equipment is identical to the 24 in. flow tube installed on the new 30 in. high pressure plant effluent line.

Pump Capacity

In 1959 the average and maximum days had reached 7.609 mg, and 10.730 mg respectively. These pumping demands are now met principally by the 9 mgd electrically-driven centrifugal pump installed in the improvement program. Electrically-driven centrifugal pumps of 3.5 and 2.0 mgd capacities supplement the 9 mgd pump in meeting peak demands. A steam turbine-driven centrifugal pump is being retained together with a boiler to provide standby capacity in case of an electric power failure. In the past, three men were used for plant operation on each shift. After electrification, the boiler was shut down and was designated as standby. It has been possible to cut the operating crew from three men to two since a boiler man is no longer needed.

* Product of Stuart Corporation, Baltimore, Md.
**Product of Builders-Providence, Providence, R. I.

Summary

The plant expansion program has completely modernized the purification plant facilities, the pumping station and related equipment for the Shenango Valley Water Company. Operating costs have been decreased by electrification, the plant filtration capacity has increased from 8.2 to 14.4 mgd, floc destruction problems due to turbulence have been eliminated, automatic sludge removal equipment has reduced maintenance costs, sedimentation overflow rates have been reduced, clear well storage has been more than doubled, problems of overflowing basins have been eliminated, and chemical handling costs have been substantially reduced.

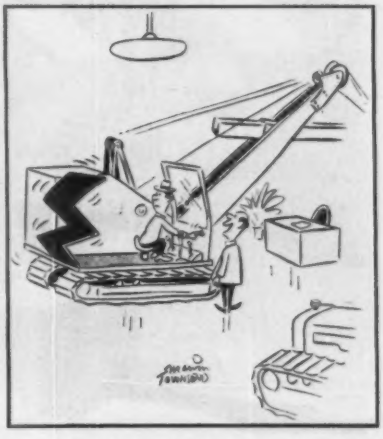
The result is a modern, efficient plant capable of supplying its commercial, industrial and residential customers with plenty of high quality water. The system is also well-equipped for emergencies and prepared for future expansion.

Ohio Water Policy Being Developed

Seven Advisory Councils appointed by the Ohio Water Commission are at work developing specific phases of Ohio's water problem. Some of these Councils have already made their preliminary reports. Each proposal is reviewed by the Ohio Water Commission and in some cases further studies have been recommended. The composite of these reports will become the basis for recommendations to the Governor and the 1961 session of the General Assembly.

All of these reports will be presented as part of the Ohio Water Management Conference which will be held December 8—9, in the Youth Center at the State Fairgrounds in Columbus. Called by Governor Michael V. DiSalle, the Conference program will be in the form of a symposium describing Ohio's present status in water development and explaining the challenge of the future.

The Conference theme on the first day will be "Where We Stand"; on the second day, "Recommendations for Policy and Action". Among the topics to be discussed in the two-day meeting will be: "Progress in Inventorying and Managing Ohio's Water Resources", "Water Planning in Industrial Development", and "A Recommended Water Policy for Ohio".



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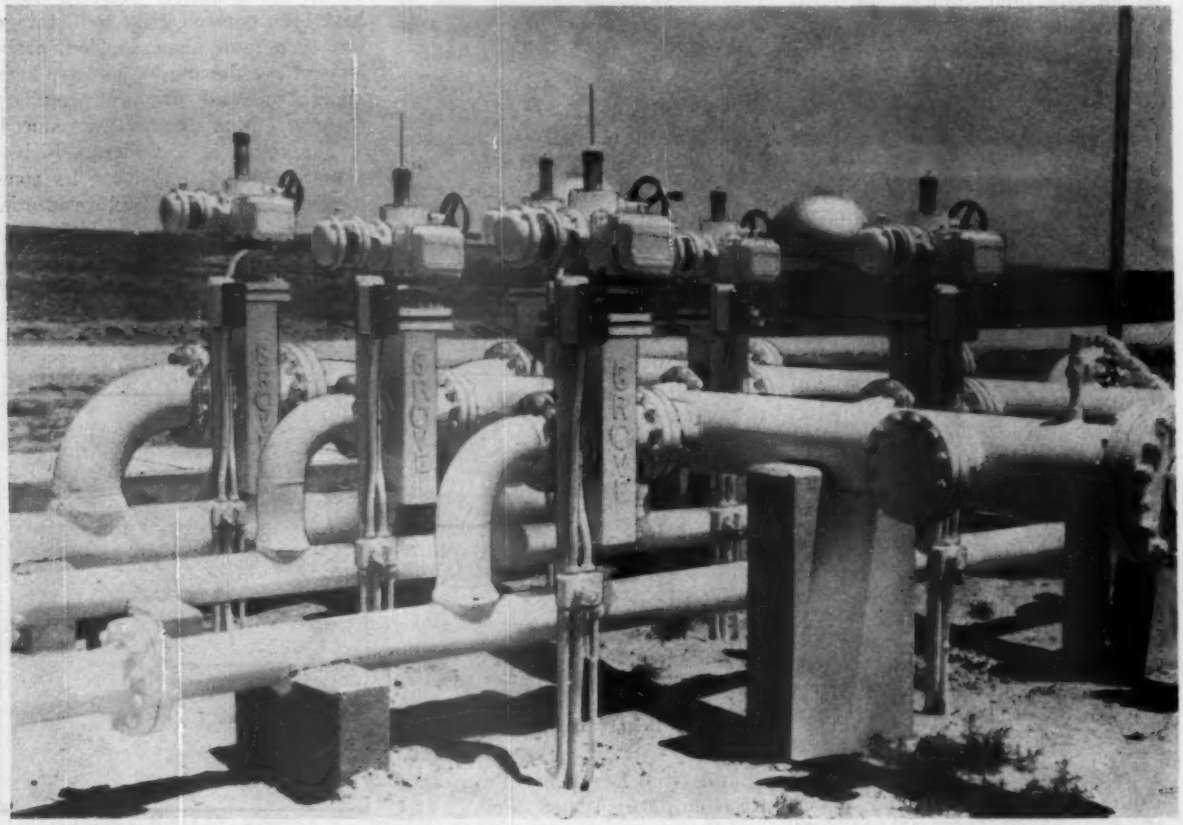
Remote Hand Control of Valves in Pipelines

EDITOR'S NOTE: Remote hand-control has long been desired as a means of emergency handling of plant valves in case of breakdown, fire, chemical escape, and the like. Some of the means currently available for accomplishing this important function are described.

by LEO WALTER
Technical Author
Painswick, Glos., England

■ AS PIPING SYSTEMS IN PLANTS become more elaborate due to increased complexity of processing, the demand for remote hand-control of valves has become widespread. To open or close a remotely located valve somewhere in a plant may be essential for correct operation of an industrial process. In case of an emergency the closing of a less accessible valve by remote operation can prevent accidents. Valve setting may be required in chemical reactions, and to do this from a centrally located control center saves



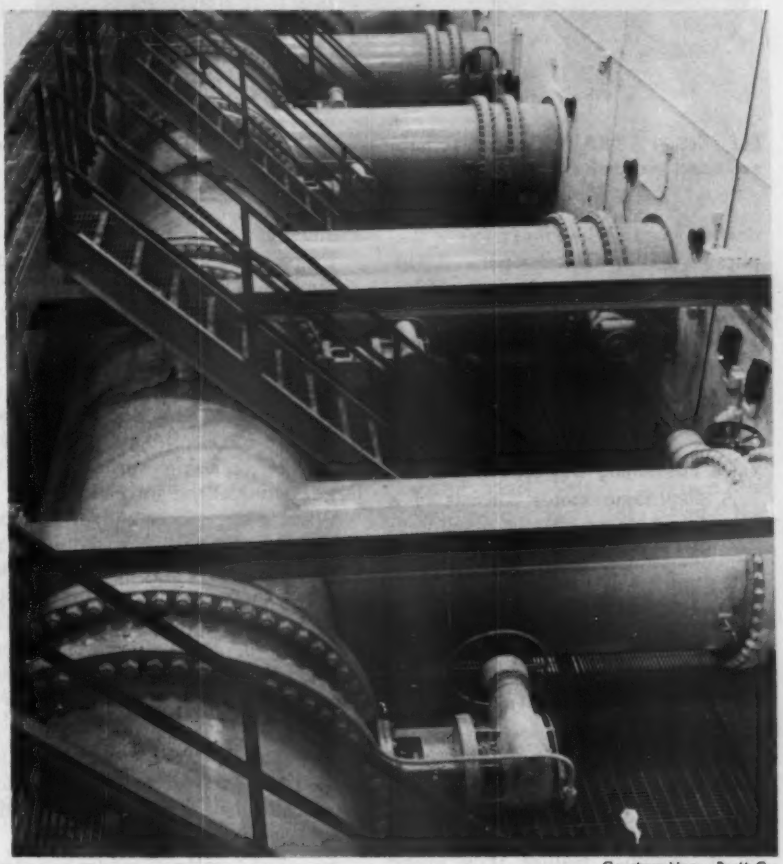
LIMITORQUE ACTUATORS on process piping valves. Courtesy Philadelphia Gear Corp.

Courtesy Henry Pratt Co.

BUTTERFLY VALVE with remote control in water main installation, Cleveland, Ohio.

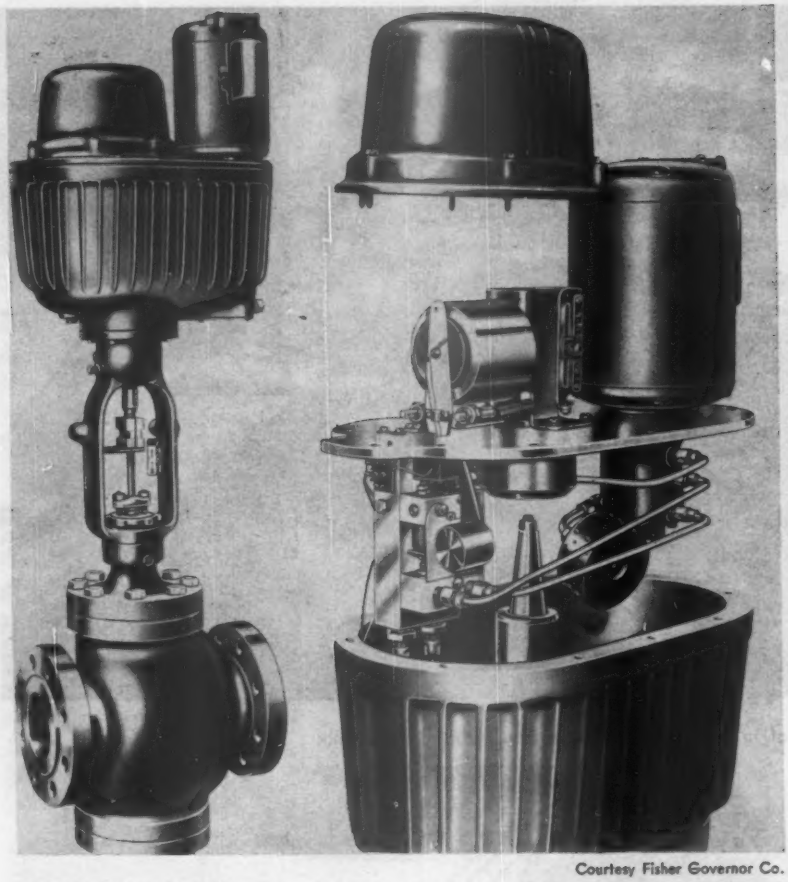
the operators time and effort. Progressive designers of piping systems in larger plants incorporate remote manual control of valves where it is indicated. Higher cost is often more than compensated by benefits derived from more efficient operation of plant equipment. It is possible, also, to supersede automatic valve control from a central control point in case of emergency. For example, automatically operated process control valves, which form part of plant control instrumentation, can be remotely closed by the supervising plant engineer from a central point in case of danger.

Valve design in general, both for hand and for automatic control purposes, has progressed rapidly in recent years. Problems of remote control can be solved today by selection from a wide range of valve designs. Makers will advise as to the best suitable designs, or the services of an unbiased consultant can be secured. The user must, however, specify clearly the actual duty of each job, which specification requires a good understanding of valve design and operation in addition to knowledge of process technology. Control valves in general can be remotely positioned by pneumatic, hydraulic, or electrical means. The positioning



Courtesy Henry Pratt Co.

NEW INTAKE and River Pumping Station in Kansas City, Mo., uses 60 in. Pratt butterfly valves for pump discharge.



Courtesy Fisher Governor Co.

ELECTRO-HYDRAULIC valve actuator, showing method of mounting (left) and exploded view of actuator unit (right).

device may be, therefore: (a) a diaphragm motor for air-operated valves, (b) a power cylinder for hydraulic or pneumatic valve designs, (c) a solenoid or an electric motor, or (d) a combination of the foregoing; (that is, electro-hydraulic valves, and the like).

Valve Positioning Devices

A diaphragm motor consists of a flexible rubber or metallic diaphragm (seamless bellows) carried on a cast-iron frame. Air pressure can be applied to one side, spring pressure to the other. Air pressure is normally applied to one flat diaphragm, but a second can be added. Thus, the valve position can be overruled by remote manual operation in case of an emergency. An important feature of the conventional diaphragm motor is its ability to take up any position according to the air pressure applied on it. Another feature is a linear relationship between applied air pressure and spindle and valve movement.

Power developed by a diaphragm is limited by the bursting pressure of the relatively thin flexible rubber, or the metallic diaphragm or bellows. Maximum air pressure may be 25 psi and diameter of a flat diaphragm as 15 in. This provides a potential actuating force of 4,400 lb. However, the opposing spring takes a large portion of this force away.

When a large force and/or greater valve disc movement is required, a pneumatic power cylinder must be used. If the relayed pressure is 150 psi and the bore is 5 in., a force of 2,800 lb can be exerted. For emergency use the power cylinder can be employed as an "open-or-shut" or "two-position" device.

Suitable choice of materials for valve body and valve trim and seat allow control of practically any fluid, whether gaseous or liquid.

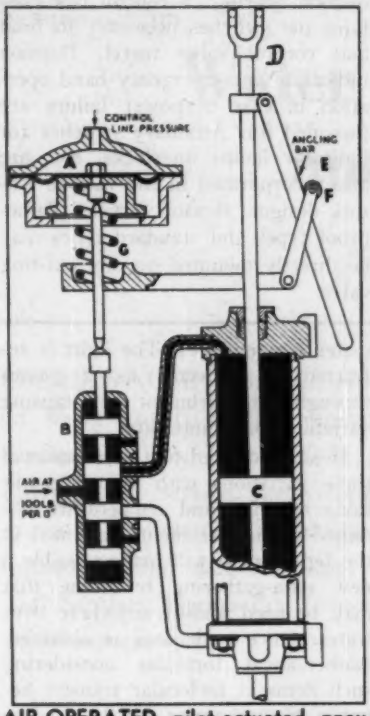
So-called "seatless" valves are also available in designs for remote control. They have no seat, but are sealed by resilient packing rings compressed around a sliding piston. Therefore, power is required only to move the piston from one position to another, no power being required to maintain the valve in either the open or the closed position. Pneumatic or hydraulic remote operation is achieved by mounting a double-acting power cylinder on the top flange of the valve body. The air-operated valve produces rapid opening or closing by means of a small hand operated pilot valve or push-button, which can be situated 100 ft. away. A single valve may be controlled from more than one location. On the other hand, a number of valves can be operated simultaneously by the same manual air control relay valve.

Control Circuits

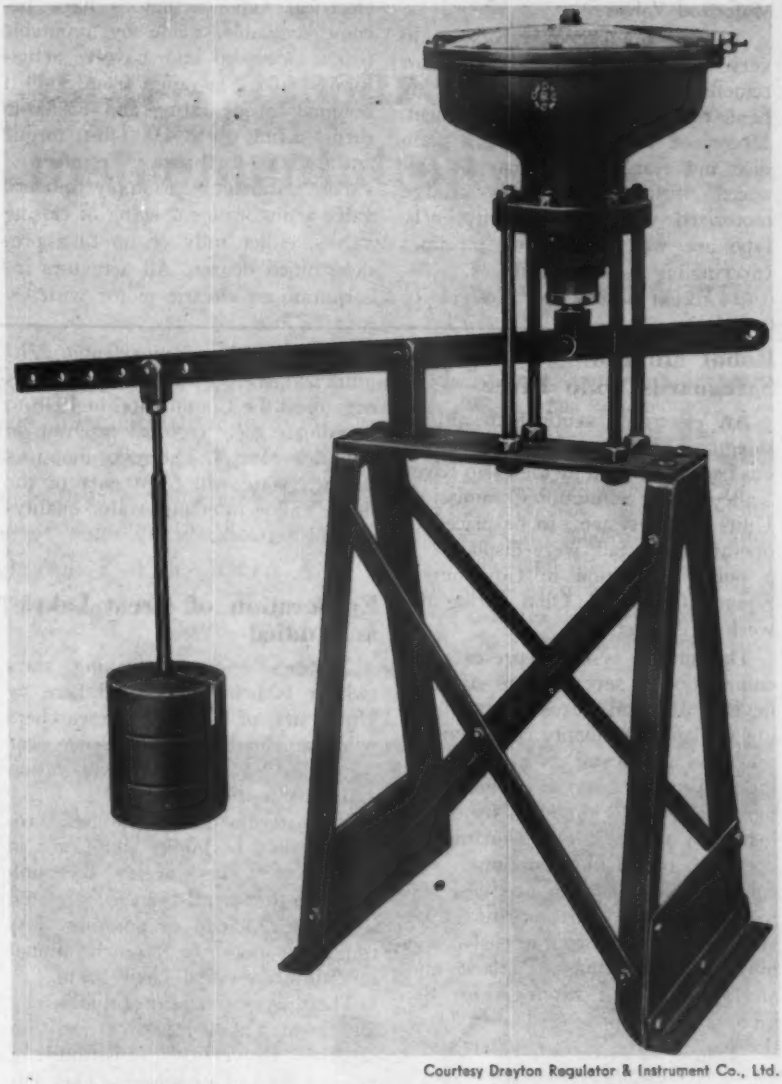
The number of pneumatic and hydraulic circuits that can be based on pilot units in combination with remote control valves is practically unlimited. It is, however, the art of the efficient designer to achieve safe efficient remote control by simple means. A typical air-operated scheme for remote hand control of several valves in a plant works is as follows. Four small air pilot valves are fitted on a control panel. They have indicating dials for ¼, ½, ¾ and fully open valve positions. These positioning relay valves are connected by ⅛ in. or ¼ in. air pipelines to diaphragm valves dispersed in the plant. Each pilot valve controls air admission to a pneumatic damper motor. Each of these actuates a large butterfly valve in a gas pipeline by means of link work.

A ½ in. air supply pipe from an electrically driven air compressor supplies compressed air to the four small pilot valves on the manual control panel. This air is supplied to each pilot at constant pressure. According to the set position of each pilot valve, which position can be altered at any time by adjustment, part of the supply air is bled off. The amount of the bleed produces a definite reduced air pressure at the diaphragm motor of the remote control valve. This, in turn, determines the main control valve position, or damper position, and the like.

One of the advantages of using compressed air as the power fluid



AIR-OPERATED pilot-actuated pneumatic power cylinder for operation of penstocks, large gate valves, and other heavy waterworks equipment. Diaphragm motor A is under varying air-line pressure according to control impulses. It positions pilot valve B, which receives full air pressure of 100 psi. Position of piston of power cylinder C is thus controlled, and piston rod D is used for regulation of large valve or gate.



Courtesy Drayton Regulator & Instrument Co., Ltd.

DIRECT-ACTING diaphragm motor for pneumatic operation.

for control gear is that it involves no fire hazard, and bleed-off can be straight to atmosphere. The use of metallic flexible seamless tubing is sometimes recommendable for easy bends and for eliminating the effects of vibration.

Hydraulic Systems

Hydraulic power cylinders use water or oil for their operation. The forces available from oil-hydraulic power cylinders are considerable, and large-diameter valves (butterfly type, etc.) can be remotely closed or opened by means of small pilot valves.

Electro-hydraulic control valves operate as follows. A small electric motor drives a pump impeller that moves oil in a hydraulic circuit. Oil pressure is used to operate the piston in a power cylinder, which in turn is connected to a lever valve. One of the most widely used actuators of this kind for very large valves or dampers is the B.T.H. electro-hydraulic Thrustor. It is a fully self-contained power unit and operates from electric current supplied from mains.

Electrically Operated Valves

Two main types of electrically actuated valves are available. Magnetic or solenoid valves are mainly used for two-step action (on-off or open-and-shut operation), where they are used as main control valves. Their application as pilot valves in hydraulic or pneumatic circuits is widespread, however, and for these control purposes solenoid valves are made in numerous designs and for widely varying duties. Magnetic pilot valves may be remotely operated by push-button switches located on a control panel. When energized, the pilot valve allows the power line pressure (compressed air, water or oil under pressure) to operate the main control valve, which employs fluid pressure by means of a flat diaphragm, a flexible metallic bellows, or a power piston as previously described. By using suitable contactor gear, it is thus possible in case of danger to close or to open several very large valves in a required sequence. A cleverly designed system of this kind may be set into immediate operation in an emergency by simply pressing a single push-button switch.

Motorized Valves

A great number of valves up to very large sizes are available for remote control purposes, whether by hand or from a control instrument. Motorized valves may have a plain disc and seat, or they may be balanced with double seats. Large motorized valves of the butterfly type are well known for pipelines carrying big gas or air volumes.

In recent years new designs of electrical valve actuators have become available, made by reputable firms. One well known valve actuator is made in a range from 50-lb-ft nominal torque rating and 12,000-lb thrust rating up to 4,000-lb-ft torque and 140,000-lb thrust. A number of valve manufacturers apply modern valve actuators for opening or closing valves, either fully or up to a predetermined degree. All actuators incorporate an electric motor with reduction gearing; a control box contains the switches necessary to limit and control valve travel. Position indication and emergency hand operation in case of power failure are provided for. Auxiliary switches for indicator lamps interlocks, etc., are also incorporated in the various Rotork designs. Buxton certified flameproof types and standard types may be directly mounted on any existing valve.

Robot Monitor Safeguards Ohio River

An electronic sentinel to aid in safeguarding streams from pollution has been developed by the Ohio River Valley Water Sanitation Commission. Units of the system, to be placed in operation this fall, were displayed at a public exhibition in Government Square, Cincinnati, Ohio during the week of August 29.

This unique system represents the culmination of several years effort to devise a practical means for maintaining vigilance on quality conditions in the Ohio River and its major tributaries. Ten years ago the Commission pioneered in this direction by establishing a network of 43 manually-operated observation stations. The robot monitors, which are designed to perform and report analytical tests automatically and continuously, will improve the existing surveillance and alert program. It promises for the Ohio Valley the first river basin in the world to be placed under automatic scrutiny for water quality protection.

Called the Orsanco Robot Monitor, the system consists of three integrated units: an analyzer and transmitter; a telemeter receiver; and a data logger and transcriber. The analyzer units may be located at any points along the river where quality checking is desired. Electronic equipment performs the tests and at specified intervals will relay the information to central headquarters in Cincinnati. Here the data is transcribed for evaluation. When unusual conditions are detected, an alert will be issued to water users and regulatory agencies in the eight states represented by the Commission.

Additional units of the prototype analyzer and transmitter are now being fabricated for delivery to the states of Illinois, Indiana, Kentucky, New York, Ohio, Pennsylvania, Virginia and West Virginia. These states organized the Commission in 1948 to coordinate their regional program of pollution control. The robot monitors in each state will form part of the Ohio Valley interstate water quality-control network.

Evaporation of Great Lakes Is Studied

Nature's trick of making stars twinkle is being duplicated here by University of Michigan researchers who are studying air turbulence over water and how it affects evaporation and wave motion.

Ultimate results of the basic research could be highly significant in the Great Lakes' water diversion problem, for scientists have estimated that the Lakes' evaporation loss roughly equals the 30-inch annual rainfall in the Great Lakes basin.

The project is one of a number by the Great Lakes Research Division of the University's Institute of Science and Technology. The Division is conducting a highly diversified investigation of the Lakes about which little is known scientifically.

The researchers' "star" is a powerful light attached to the Charlevoix breakwall which hurls its beam a mile and one-half across Lake Michigan waters into the lens of a telescope located on a point of land below the city. At the rear of the telescope is a photocell which translates the light's twinkling into electrical energy so that the fluctuations may be recorded in graphic form.

Just as a star appears to twinkle because the earth's atmosphere varies in density, so does this light twinkle as it passes above the water's surface. In the case of the man-made light, the atmosphere is air immediately above the water made turbulent by variations in the wind and air and water temperatures. The light is refracted or deflected as it passes through this turbulent air, causing variations in its intensity.

It is anticipated that correlation of these variations with known conditions of wind and temperature obtained from instruments stationed in the light's path will make possible a new data-gathering technique that may be used almost anywhere over water. Once such data is obtained, mathematical formulas considering such items as molecular transfer between air and water will be used to determine findings.

Denver's Metropolitan Sewage Plan Upset

Denver's master plan to establish a metropolitan sewage disposal district suffered a serious set-back when the proposal was rejected by suburban Aurora's City Council.

The suburb was one of six cities or sanitation districts whose approval of the plan was necessary, under the terms of a Denver ordinance already passed, before the metropolitan district could be established. Aurora's action apparently has stymied the proposal, for the present time at least.

Denver's Mayor Dick Batterton expressed amazement and disappointment when he learned Aurora's action, but indicated that he was not allowing the issue to die.

Aurora's Mayor Henry W. Allard did not rule out the possibility of some kind of future agreement.

Under Colorado law enacted earlier this year, the city originating such a proposal names those entities which must join the district in order to permit its creation. A "permissive" list is also set up. This list includes cities that can join the district at a later date. Aurora wished to be included in such a list.

Symposium on . . .

Water Quality Measurement and Instrumentation

A report by
V. W. LANGWORTHY

EDITOR'S NOTE: This will initiate a report on the Symposium on Water Quality Measurement and Instrumentation held in Cincinnati, Ohio, August 29-31, 1960, sponsored by the U. S. Public Health Service. The symposium featured sections on the role of water quality data, the utilization of water quality data use, instrumentation, data handling, and a tour of the Robert A. Taft Sanitary Engineering Center. This report will be continued in subsequent issues.

Role of Water Quality Data

■ THE CHAIRMAN for this section of the symposium was Mark D. Hollis, Assistant Surgeon General of the U. S. Public Health Service and President of the Water Pollution Control Federation. The lead-off speaker for the session was Harry G. Hanson, Director of the Sanitary Engineering Center, U. S. Public Health Service, Cincinnati, Ohio. Speaking on the measure of **Water Quality—Its Present and Future Significance**, Mr. Hanson said that among the considerations surrounding this subject of Water Quality Management is that presently water quality management is a concept rather than a practice. This is particularly applicable to surface water. He defined adequate water quality management as having the right water quality at the right place. Of the 314 bgd available in the U. S., the major portion is of inadequate quality and perhaps more of the total daily run-off could be made available if the quality were improved. This supply may be augmented from ground water, weather modification, and desalting of saline water. Water will be increasingly reused in the decades to come, and it will be necessary to keep meeting the requirements. It is important that in surface streams and their uses—consumptive, non-consumptive, and recreation (which use is on the rise), it is necessary to know how to measure quantity and quality and to exercise discrimination in what to measure. The chemical, biological and physical content and the interplay of the various compounds is essential. Progress has been made in control of pollution, though this problem is by no means solved. Progress has been made in soil conservation, but the impact of thermal pollution, chemical and biological identification separation and instrumentation are only in the primary stages. We need more sensitive, less costly, and faster methodology in this connection.

FIG. 1. NATIONAL WATER QUALITY NETWORK EXHIBIT shows station locations, natural and contaminant levels. At right is membrane filter apparatus above carbon filter sampling cartridge.

A water cleaning technology and the determination of pollutional characteristics of water indicates the need to devise new treatment methods, as present means are totally inadequate and more research is needed in this area. The language needs a common

ground and he suggests a reduction of all possible inter-related information to mathematical language. The whole process is similar to an accounting procedure and answers are needed now in some regions to facilitate adequate water quality management.

Requirements for Criteria of Water Quality was presented by Jack E. McKee, Professor of Sanitary Engineering, California Institute of Technology, Pasadena, California. Beginning his discussion, Professor McKee defined a *standard* as a definite rule, or principle established by authority which may not be fair or scientifically sound, but is held in quasi-legal status. He defined an *objective* as an aim or goal toward which to strive, but non-legal in its interpretation. *Criterion* is anything tried in seeking a result, and it should be allowed to become rigid. *Water use* may be classified as beneficial or economic and data collected should be related to one of the beneficial uses. A partial listing of areas in which he said there were gaps in knowledge or missing informa- included the following: Synergism and antagonism among wastes and their rates, relationship of water quality to differentiate mixing, threshhold concentration of exotic chemicals, radioactivity, subtle long-range physiological effects of certain materials, available water quality based on poor methods and continuous data-providing equipment.

Evaluation of Water Quality Protection Techniques was provided by Bernard B. Berger, Chief, Research Branch, Division of Water Supply and Pollution Control, Public Health Service, Robert A. Taft Sanitary Engineering Center, Cincinnati, Ohio. The Sanitary Engineering Center is in a good position to be aware of existing techniques useful in determining techniques useful in determining water quality. He reported the following items to be an essential part of techniques necessary in protecting water quality. Accounting of wastes appears necessary, including sewage, industrial wastes, land drainage and exhaust from motor boats. Prediction of pollution effects, which only a few U. S. laboratories have the ability to do. Existing knowledge on mixing theories, for example, may not be properly applied. Monitoring techniques, such as the use of aquatic life to serve as indicators of pollution require further study. At present, water treatment plants are not equipped to cope adequately with materials and solutions other than hardness chemicals. There is a constant search for new physical and chemical analytical techniques.

Harvesting Water Quality Data was presented by Walter A. Lyon, Director, Division of Sanitary Engineering, Pennsylvania State Department of Health, Harrisburg, Pennsylvania. Programs of water quality protection must at present proceed in an absence of adequate analytical means and instrumentation. Better communications are required for dealing with non-scientific people. He noted that technicians cannot agree among themselves on how to approach the solution of water quality problems. Data are needed to evaluate water quality, and although often accumulated they are not readily usable. Duplication of effort was noted in one stream in particular where over forty organizations had been reported all engaged in determining essentially the same type of information. This appears to be wasteful of funds, personnel and laboratory facilities which may be badly needed for other activities. Mr. Lyon proposed the establishment of a clearing house for accumulated data insuring availability to all interested parties. Required would be uniform analytical techniques fairly well taken care of at present by Standard Methods. Uniform methods of reporting are badly needed at present as is one or a series of data clearing stations, either local or national. A good start already exists in the presently existing U. S. PHS Water Quality Network. The effort in establishing such a clearing house would have to be cooperative to the extent that all data would be transmitted to the central area, including all past, present, and future accumulated information. He suggested the possibility of using volunteer help to perform the mountainous clerical task of placing historical water quality data into mechanical data handling systems.

Discussion of the role of water quality data brought out important points particularly from R. S. Ingols, Georgia Institute of Technology, Atlanta, Georgia, who wished to emphasize the effect of hydraulic power generation on upstream and downstream conditions and the difficulty resulting from sudden changes in stream flow. Further discussions surrounded the adequacy of U.S. PHS standards on bathing waters, the epidemiology of which has not been apparently adequately studied.

One proposal was made that out of the Water Quality Measurement and Instrumentation Symposium should come a committee organized to establish communications among the attendees so that items proposed could receive subsequent attention.

Utilization of Water Quality Data

Two panel discussions were under the chairmanship of S. Kenneth Love, Chief, Quality of Water Branch U. S. Geological Survey, Washington, D. C. the first panel discussed Water Quality Parameters.

Physical and Chemical Parameters was reviewed by T. E. Larson, Head, Chemistry Section, State Water Survey Division, Urbana, Illinois. In a sampling program for physical and chemical characteristics, the type and frequency of sampling depends on the objective. Also essential are previous records and periods of observation. The representative nature of the sample, its location, temperature, date and time must be rigidly followed. Unusual information, when observed, should be recorded. He noted shortcomings of physical and chemical parameters; they may be too involved for analysis and may not be important when compared with the time and exacting techniques required in their execution. Dr. Larson cautioned chemists and trained technicians to be critical of analytical devices, such as photometers and pH instruments, and not fall into a trap of reading and interpreting the results without being certain that the devices are in proper operating order. Importantly, he noted that physical and chemical parameters are valuable over and above those which may be standard and required because they provide information to readers, tie in with other information, and should by all means be recorded for general information.

Aquatic Organisms was discussed by James B. Lackey, Professor of

Sanitary Science, College of Engineering, University of Florida, Gainesville, Florida. Water has a diverse group of interested users and biological parameters do have their effect on water quality. Fallen leaves cause color production and release trace amounts of chemical when decomposition takes place in surface water. Growing plants also add to the load of biological material which can have an effect on water quality. Dr. Lackey noted that there were few standards for non-bacterial organisms in potable water. Such standards seem to be needed on the basis of the experience of a Florida City supply. Numerous types of free swimming and fixed proteinaceous animal life and samples were collected from this distribution system and centrifuged. Since small animals of this type are not removable by the filtration process, they must be killed by other means. Similarly, aquatic organisms can cause pollution of water crops including watercress, shell fish; thus a standard other than coliform may be required. Similarly, additional studies are required in understanding marine water. Further information is needed to understand the mechanisms of organisms contributing to filter clogging, as well as dissolved oxygen-reducing organisms. The study should be continued on H_2S and other contaminating materials which may be produced by aquatic organisms. It is vitally important that improvement be made in sampling and analytical techniques associated with biological parameters.

FIG. 2. U. S. PUBLIC HEALTH SERVICE personalities participated in Symposium. Left to right they are: M. D. Hollis, Asst. Surgeon General and Chief Engr., Gordon McCallum, Chief, Division of Water Supply and Pollution Control, H. G. Hanson, Director, Sanitary Engineering Center, and R. C. Palange, Deputy Chief, Basic Data Division of Water Supply and Pollution Control.

Bacterial Parameters was discussed by Paul W. Kabler, Chief, Microbiology Section, Research Branch, Division of Water Supply & Pollution Control, Public Health Service, Robert A. Taft Sanitary Engineering Center, Cincinnati, Ohio. Three bacteriological parameters were discussed; namely, coliform, fecal coliform, and fecal streptococci. (Fecal coliform: those which ferment lactose and produce gas at 45°C.) He referred to the presence of false positive groups of organisms and methods which have been evolved to control interference in bacteriological analytical methods. Differentiation between animal and human organisms is not required because the presence of both indicates that the water probably was not suitable for potable purposes. Bacteriological analysis has improved over the years with the development of newer techniques to perform specific functions. Fecal coliform organisms in untreated water indicate recent pollution. Fecal streptococci consistantly present in polluted soil and raw water are differentiated by currently available tests, according to Kabler.

Organic Chemicals, was discussed by Francis M. Middleton, Chemistry & Physics Section, Research Branch, Division of Water Supply and Pollution Control, Public Health Service, Robert A, Taft Sanitary Engineering Center, Cincinnati, Ohio. The historic BOD and COD tests imply that oxygen-using materials are present, though complete information is not provided by any means. These tests, together with methods for the determination of phenols and phenolic compounds, tannins and liginins, oil and grease, and volatile acids are about the extent to which Standard Methods go in prescribing means for identifying organic chemicals. World War II was followed by diverse and unique problems caused by an increase in demand for improved pure water both for public and industrial purposes. Analytical methods are not adequate to solve problems or correct damages which may occur. Foaming at sewage treatment plants was probably an eventual result of the increased use of synthetic detergents and no good method is available for syndet analysis.

He proposed that monitoring the water would reveal the presence of contaminants and the information would be valuable as a base line and assist in determining long term and subtle trends. Further methods are needed to describe contaminants.

Radioactivity Data; Its Significance was described by Conrad P. Straub, chief, Radiological Health Research Activities, Robert A. Taft Sanitary Engineering Center, Division of Radiological Health, Public Health Service, Cincinnati, Ohio. Data presented from the Water Quality Network's sampling program, beginning with October 1958 through March 1960, showed a substantial falling off of strontium-90 levels in U. S. surface streams. This is ascribed to the absence of the weapons testing program. Data also indicate a well defined relationship between alpha activity and suspended solids on samples analyzed from the Red River at Alexandria, Louisiana. This relationship cannot be demonstrated for gamma activity. Background data on radioactivity of surface waters was correlated with studies at water treatment plants on removal, particularly studies involving water treated at the South District Filtration Plant, Chicago, Illinois. In spite of the high degree of treatment provided at this plant, the process was found to be ineffective in reducing the amount of radioactive materials in Lake Michigan raw water. It should be noted that gross activity levels have been low (below 100 peco curies). Whenever radioactivity data are presented, specific information on specific radionuclides should also be included.

Partially Oriented on . . . . .

My Galoshes

I BELIEVE there are still some people around who think it is an honourable thing to die with one's boots on. If this means that I, as an engineer, am expected to die with my galoshes on, then I wish it to be known in advance that it will have been no intention of mine. On the contrary, if I should at any time be found lifeless in galoshes, then it is because of the galoshes that I shall be found lifeless, and those whose debts I might have paid had I lived longer should sue these boots for the recovery of their losses. As far as I am concerned, I would rather shuffle sensibly and comfortably away in carpet slippers.

There are three hazards in connection with the wearing of galoshes: (1) the putting of them on; (2) the wearing of them for any period greater than twenty minutes; and (3) the taking of them off. Of these operations, the last two are most likely to be the cause of premature death; for while the putting of boots on is undoubtedly a dangerous occupation, it is unlikely to result in immediate extinction.

For instance, let us take this pair of boots of mine that have been standing about in the room tripping me up every time I have made a move. There is mud on the outside of them, and there is mud on the inside of them. As regards the mud inside them I am merely stating a fact, not offering an explanation. I uplift one of the boots and scrape away at some congealed mud in the heel of the boot. This mud partially scrapes away and falls down the sleeve of my shirt, so I will now invert the boot and arm again, when the mud falls into the boot again. It is now necessary to bang the boot on something handy, such as this desk here. (This explains the ineradicable dirtiness of my official correspondence). After a number of bangs I try a foot into the boot, only to discover that there is a large nutmeg of something left inside, either between the first and second toes, or between the second and third toes. I cannot tell which toes the nutmeg lies between because there is a want of sensitivity in my feet which comes, I suppose, from bashing them around too frequently on lumps of site concrete.

Removing the foot, let us now be brave and plunge a hand up to the toe of the boot to find out what lump of siltstone or hardcore has got itself fixed up there. The result of this tactical exploration is a little surprising—in fact a little bit revolting. Mind you, there is nothing basically revolting about my feet or my socks. None of my best friends have made any special comments of revulsion about this subject and I wash them pretty often—my feet and socks I mean, not my friends. Up in the toe of the boot one would expect it to be flat and dry. It is not. It is all cockled up and damp. Obviously my toes have a distressing time up there, but without a periscope and lamp it is rather difficult to find out the exact reason for it all. I peel away a damp strip of something and uncockle some of the cockling, and give another whack or two of the boot on the desk and try pressing the foot in again. On the whole I could not say that it is real pain that attacks me—it is a midway feeling between discomfort and agony, and if we are to get out at all today we had better put up with it.

The second boot is now put on, and is instantaneously removed by a reflex action. This is because it has been standing as a receptacle under the first area of operations and I have forgotten to pour the contents out. This I do and re-insert the foot and then, standing up, I try and decide whether sufficient preparation has been undertaken for it to be safe to take a few steps.

I do not know how it comes about, but in no more than a couple of dozen steps these galoshes of mine can strip me practically nude. After a dozen strides my trousers come out of the tops of the boots and my socks fall down to the heels; after a dozen more strides my socks are peeled right off my feet and there I am standing naked in galoshes with my bare feet stubbed against bunched-up socks in the toes of the boots. Thus it comes about that, after every twenty yards or so, I have to imitate a heron in the mud, and stand poised on one leg trying to re-sort out the contents of each boot in turn. This is not the kind of activity I like to undertake in the middle of a construction site as there is always someone around who is too quick to appreciate (and comment on) another person's discomfiture. However, with tenacity and grit it is possible to keep going.

How long one keeps going is, of course, a matter of constitutional fitness. There was, for instance, a man who walked from John o' Groats to Land's End in galoshes. Or at least I believe he *set out* from John o'Groats in galoshes. I should like to meet that man, if he is still alive today. Probably, for reasons I will now explain, he is more likely to be dead.

As you well know (and even if you don't it doesn't matter as I'm going to tell you anyway), most of our legs and feet are made of water. And the process of life—the inbalance and exbalance necessary to keep things fresh and moving instead of rotting away—means that we take up oxygen and expel water all the time. Some of the water comes out through our feet. In fact quite a lot does, as water is naturally gravitationous and gets to the feet more easily than the head. But inside the galosh none of this water can get away. The water that cannot get away hangs around, and slowly the natural routine of life comes to a stop. When this happens the feet are on the point of beginning to rot away and the boots should be taken off if you want to continue living. This may not be a completely scientific explanation of the whole phenomenon, but at least it explains what happens to *my* feet after twenty minutes or so in galoshes.

Only one thing remains to be done—to take the boots off as quickly as possible and expose the feet to the air. However, let me add this note of warning to those of advancing years or obese figure. Do not invert the person too precipitously in an effort to get the boots off, lest the rush of blood to the head cause a stroke. Get a friend to assist you in your hour of need, even if he sues you for a new suit of clothes.

Both as an introduction for some and as a review for others, presented here are . . .

Some Applications of Elementary Solution Equilibrium Chemistry

by VAUGHN C. BEHN, Dr. Eng.
Assoc. Prof. of Civil Engineering
Univ. of Delaware, Newark, Del.

EDITOR'S NOTE: Some comprehension of the principles underlying the subject of equilibrium chemistry as applied to water is necessary for a more complete understanding of new developments in corrosion prevention, controlled scale formation, water softening, and waste treatment. This paper presents these principles in a concise and readily understandable manner for those interested in the production of *Quality Water*.

■ AN INSPECTION of a number of short course proceedings and undergraduate texts in the water and waste field reveals that equilibrium chemistry is usually not offered with the instructional material.* While the subject us usually introduced in the first chemistry courses, the student comes to realize the full value of the material only in later courses. Since the more advanced of the elementary chemistry courses are not included in a typical civil engineering curriculum, this appreciation might not be reached by many workers in the field. This is perhaps unfortunate, since equilibrium chemistry can bring added depth of understanding to many of the phenomena in water and waste treatment. The intention of this paper is to substantiate this statement by demonstrating some applications of elementary equilibrium chemistry.

Mass Law

The case for equilibrium chemistry is revealed almost at once in its origin. C. L. Berthollet, while serving as scientific adviser to Napoleon, noticed that certain salt lakes in Egypt had significant deposits of sodium carbonate. Apparently a reaction was taking place which was in the opposite direction to the laboratory experiment in which sodium carbonate reacts with calcium chloride to precipitate calcuim carbonate. Berthollet's conclusion was that the high concentration of sodium chloride and dissolved calcium carbonate was responsible for the reversal of the laboratory reaction. Thus in 1799 there was a clear understanding (by at least Berthollet) that the concentration of reactants can influence the extent of the reaction and composition of the products.

Despite some opposition, Berthollet's work was slowly amplified into a foundation which reached its culmination in the law of mass action as presented by Guldberg and Waage about 1867. According to this law, the rate of a chemical reaction is proportioned to the active masses of the reacting substances. The active mass was initially interpreted as the molecular concentration of the substance.

Equilibrium Constant

The mass action law was recognized by Guldberg and Waage as a convenient means to establish quantitative relationships in chemical equilibria. Today we express this in terms of an equilibrium constant, K, which is readily derivable from the mass action law.

As an example, we might take the reaction of A and B to form products C and D. Expressed as a reversible chemical reaction, this may be written

$$A + B \rightleftarrows C + D \qquad (1)$$

According to the mass action law, the rate at which A and B react is proportional to the concentration of each. Expressing the molecular concentrations of A and B by adding parentheses, the mass action law states that the reaction rate to the right is proportional to (A)(B). For ease in mathematical formulation, a constant of proportionality, k_r, is introduced as follows:

$$\text{Rate (to right)} = k_r(A)(B)$$

The rate of the reverse reaction of C and D to form A and B may be similarly expressed:

$$\text{Rate (to left)} = k_l(A)(B)$$

When equilibrium exists, the reactions to the right and left are equal. Under these conditions:

$$k_r(A)(B) = k_l\,(C)(D)$$

or

$$k = \frac{k_r}{k_l} = \frac{(C)(D)}{(A)(B)} \qquad (2)$$

The equilibrium constant, K which is substituted for k_r/k_l is thus ex-

*A text which is an exception has become available since this paper was prepared. See *Chemistry for Sanitary Engineers* by C. N. Sawyer, McGraw-Hill, 1960

pressed in terms of concentrations, usually molar.

A more general form of equilibrium constant may be deduced if a slightly more complex reaction is considered. Suppose, for example, a reaction similar to (1) except that two moles of B are involved. This reaction is:

$$A + 2B \rightleftarrows C + D$$

This may also be written:

$$A + B + B \rightleftarrows C + D$$

The reaction rate to the right now becomes:

Rate (to right) $= k_r(A)(B)^2$ and it follows that the equilibrium constant is defined by:

$$K = \frac{(C)(D)}{(A)(B)^2} \qquad (3)$$

Equation (3) suggests that for the general reaction of the type:

$$mA + nB \rightleftarrows pC + qD$$

The appropriate equilibrium constant is:

$$K = \frac{(C)^p(D)q}{(A)^m(B)^n} \qquad (4)$$

Equation (4) is the basis for the examples cited in this paper. The interested reader with the necessary background will find that it is possible to derive (4) from thermodynamic principles, and that in fact K has a derivable relationship with energy changes involved in the reactions.[1] Fortunately, these more sophisticated aspects of the equilibrium constant need not be measured to utilize the constant. However, there are certain factors which must be kept in mind. First, the constant changes with temperature, and secondly, strict adherence to equation (4) is followed only in very dilute solutions. This latter problem was overcome by the introduction of the concept of activity.

Activity

When it was observed that equation (4) was not adequate except in very dilute solutions, Lewis introduced the activity coefficient, which is commonly denoted by the letter f (or the Greek letter gamma). The product of f and the concentration is termed the activity. Since f is a dimensionless factor having a value from zero to unity, activity has the same units as concentration.

The activity coefficient was originally thought of as an empirical modifying factor. The need for such a factor was based upon observation that the effective concentration of a material in solution decreased as the concentration of electrolytes increased. This behavior was ascribed to interionic attraction. (A very crude analogy would be to compare the progress of an individual attempting to walk rapidly along a busy street with his progress along a country lane.) Subsequently the whole concept of activity was put on a strong theoretical basis by the work of Debye and Hückel, and it is now possible to compute activities from theoretical considerations.[2, 3]

The substitution of activity for molar concentration, therefore, requires the ability to calculate the activity coefficient. Fortunately, many water and waste solutions are quite dilute so that it is permissible to apply a coefficient of unity for purpose of calculation. Also, since equilibria concepts are valuable for qualitative as well as quantitative reasoning, much can be learned about various phenomena without resorting to calculation of activity coefficients. However, some phenomena, such as the increased solubility of $CaCO_3$ in salt over that in pure water, can only be explained on the basis of activities.

With this qualification in mind we may now proceed to the various specialized types of equilibrium constants of interest in water and waste engineering.

Specialized Equilibrium Constants

The most useful type of specialized equilibrium constant in water work is the dissociation constant for weak acids. If one takes an acid such as hypochlorous acid in contact with water the reaction is:

$$HOCl + H_2O \rightleftarrows H_3O^+ + OCl^- \qquad (5)$$

The equilibrium constant is then:

$$K' = \frac{(H_3O^+)\quad(OCl^-)}{(HOCl)\quad(H_2O)}$$

Now the undissociated water concentration, (H_2O), is considered as a constant quantity and may be multiplied by K′ to give the dissociation constant K:

$$K = K'(H_2O) = \frac{H_3O+)\quad(OCl-)}{(HOCl)} \qquad (6)$$

The use of the hydronium ion, (H_3O^+), is adhered to by many writers since the hydrogen ion is apparently hydrated, but the simpler form, utilizing the more familiar hydrogen ion concentration, (H^+), is numerically equivalent and will be used in this paper. Thus (6) becomes:

$$K = \frac{(H^+)\quad(OCl^-)}{(HOCl)} \qquad (7)$$

This form suggests that the original reaction (5) could have been written:

$$HOCl \rightleftarrows H^+ + OCl^- \qquad (8)$$

When more than one hydrogen exists in the acid the convention is to show the dissociation in step-wise form, giving the ionization constant a subscript of 1, 2, 3, etc.

For a dibasic acid such as carbonic acid the dissociation steps are:

$$H_2CO_3 \rightleftarrows H^+ + HCO_3^-$$

and $$HCO_3^- \rightleftarrows H^+ + CO_3^-$$

The dissociation constants are, therefore:

$$K_1 = \frac{(H^+)\quad(HCO_3^-)}{(H_2CO_3)} \qquad (9)$$

$$K_2 = \frac{(H^+)\quad(CO_3^-)}{(HCO_3^-)} \qquad (10)$$

Other useful forms of the equilibrium constant are the various solubility products and the ionization constant for water. The solubility product is formed by considering the concentration of the solid material as a constant. For example, consider the reaction by which solid magnesium hydroxide dissolves to form magnesium and hydroxyl ions:

$$Mg(OH)_2 \rightleftarrows Mg^{++} + 20H^- \qquad (11)$$
(solid)

The equilibrium constant is:

$$K' = \frac{(Mg^{++})\quad(OH^-)^2}{(Mg(OH)_2)}$$

The concentration of solid $Mg(OH)_2$ is multiplied by K′ to yield K_s, the solubility product:

$$K_s = K'(Mg(OH)_2) = (Mg^{++})(OH^-)^2 \qquad (12)$$

Equation (12) demonstrates the reason why the addition of lime decreases the solubility of magnesium hydroxide in water softening. The hydroxide ions from the dissolved lime add to the OH^- concentration in parentheses in (12). Since the product, K_s, is a constant, the value of (Mg^{++}) must decrease. Since (Mg^{++}) represents the dissolved magnesium hydroxide from (11), it is obvious that the concentration of magnesium hydroxide must decrease and it therefore precipitates.

In the case of the ionization constant for water, the dissociation is: $H_2O \rightleftarrows H^+ + OH^-$ and the equation for the equilibrium constant is:

$$K' = \frac{(H^+)\ (OH^-)}{(H_2O)}$$

As before, the concentration of undissociated H_2O is considered as a constant and is multiplied by K' to give the ionization constant, K_w, which is unique for water:

$$K_w = K'(H_2O) = (H^+)\ (OH) \qquad (13)$$

On inspecting this equation, it can be seen that, no matter how high the concentration of hydroxyl ions may be, there must remain sufficient hydrogen ions to satisfy the equation. Therefore, in expressing either the active acidity or alkalinity of a water solution, it is sufficient to give only the hydrogen ion concentration. From this, the hydroxyl ion concentration may easily be calculated.

In arriving at these various specialized constants, it was observed that not only could the values be manipulated algebracially, but that if logarithms were taken, useful expressions could be derived for special situations. For example, early investigators found that expressing the hydrogen ion concentration as gram ions per liter gave a value that was awkward to use. In much of their work the term, $\log \frac{1}{(H^+)}$, occured, and it was seen that this term defined the hydrogen ion concentration as accurately as the term, (H^+). For simplicity the value for the term, $\log \frac{1}{(H^+)}$, was given the symbol, pH.

This same convention can also be applied to any of the concentrations in these equations for dissociation constants and also to the constants themselves. Equation (13) may therefore be rewritten as: $pK_w = pH + pOH \qquad (14)$

At 25°C. the value for K_w is almost exactly 1.0×10^{-14} and pK_w is then, 14. At this temperature, therefore, pOH can always be found as the difference between 14 and the pH value. For example, after softening, a water might have, at 25°C., a pH of 9.85. The pOH would be 4.15. Since these are negative logarithms they must be converted to the usual form. 9.85 becomes 10.15, for which the antilog is 1.41×10^{-10}, the actual hydrogen ion concentration as gram ions per liter. The pOH value of 4.15 becomes 5.85, for which the antilog is 7.08×10^{-6}, the hydroxyl ion concentration as gram ions per liter. This may be expressed as mg. $CACO_3$ per liter by multiplying by 50,000. Thus, at 25°C., in a water having a pH value of 9.85, the hydroxyl ion concentration, as mg. $CaCO_3$ per liter is $50{,}000 \times 7.08 \times 10^{-10}$ or 3.54. Either the pOH value or the hydrogen ion concentration found above could then be used in equation (12) or its equivalent: $pK_s = 2pOH - \log(Mg^{--})$ to predict the minimum concentration of magnesium that could be expected in a water with a pH of 9.85.

Buffering and pH Indicators

A buffered solution is one which has capacity for receiving an acid or base without alteration in pH. This becomes possible when the strongly dissociating salt of a weakly dissociating acid is combined with the acid. This may be demonstrated for acetic acid. The reaction is:

$$HC_2H_3O_2 \rightleftarrows H^+ + C_2H_3O_2^-$$

The dissociation constant is given by:

$$K = \frac{(H^+)\ (C_2H_3O_2^-)}{(HC_2H_3O_2)} \qquad (14)$$

Taking logarithms of both sides and rearranging:

$$-\log (H^+) = -\log K + \log \frac{(C_2H_3O_2^-)}{(HC_2H_3O_2)}$$

Utilizing the convention that the negative logarithm of a quantity can be expressed by inserting a p before the quantity, there results:

$$pH = pK + \log \frac{(C_2H_3O_2^-)}{(HC_2H_3O_2)} \qquad (15)$$

In a buffered solution the salt supplies the acetate ion and the acid provides the undissociated acid. When a given quantity of hydrogen ions are added from an external source the $(HC_2H_3O_2)$ will increase and the $(C_2H_3O_2^-)$ will decrease by the given amount. If this change is small compared with the original concentrations, the ratio will be little affected and the pH will therefore remain approximately constant (since pK is constant). An analagous situation will occur if hydroxyl ions are added from an external source.

A similar approach is used to understand pH indicator solutions, which are weak acids. Designating an indicator solution by the shorthand form HIn, the reaction is:

$$HIn \rightleftarrows H^+ + In^-$$

Taking logs and rearranging:

$$pH = pK + \log \frac{(In^-)}{(HIn)} \qquad (16)$$

Since the color of pH indicators depends upon whether it is in the form of the ion, In^-, or the undissociated molecule, HIn, it is apparent from (16) that the color will change with pH of the solution.

Other useful information can also be obtained from manipulation of the equilibrium constant. Two excellent examples of this would include the ability to predict the form which a compound might take at varying pH, and the well known Langelier saturation index.

Form of Compound Versus pH

One of the most useful applications involving manipulation of equilibrium constants involves the form which CO_2 will take in water. Let us take, for example, a water containing CO_2 at a relatively low pH. The CO_2 will be loosely bound to form H_2CO_3. If the pH is artificially increased by the addition of, say, sodium hydroxide, the solution will gradually take on in turn the characteristic of sodium bicarbonate, $NaHCO_3$, and sodium carbonate, NA_2CO_3. The technique described below permits the determination of the fractions of CO_2 which will appear as carbonic acid, bicarbonate, or carbonate at various levels of pH. If these are designated as x, y, and z respectively the following relationships are written down immediately.

$$x = \frac{(H_2CO_3)}{(H_2CO_3) + (HCO_3^-) + (CO_3^-)}$$

$$y = \frac{(HCO_3^-)}{(H_2CO_3) + (HCO_3^-) + (CO_3^-)}$$

$$z = \frac{(CO_3^-)}{(H_2CO_3) + (HCO_3^-) + (CO_3^-)}$$

An expression for x is now obtained by dividing through by (H_2CO_3):

$$x = \frac{1}{1 + \frac{(HCO_3^-)}{(H_2CO_3)} + \frac{(CO_3^=)}{(H_2CO_3)}}$$

This expression for x is put in terms of K_1, K_2 and (H^+) by using expressions (9) and (10).

$$x = \frac{1}{1 + \frac{K_1}{(H^+)} + \frac{K_1K_2}{(H^+)^2}} \quad (17)$$

Similarly it can be shown that

$$y = \frac{1}{1 + \frac{(H^+)}{K_1} + \frac{K_2}{(H^+)}} \quad (18)$$

$$z = \frac{1}{1 + \frac{(H^+)}{K_2} + \frac{(H^+)^2}{K_1K_2}} \quad (19)$$

It is now obvious that for values of K_1 and K_2 taken from handbooks or the literature[3], x, y, and z may be computed for any value of pH. In fact, the simplest procedure for use of this technique is to prepare graphs showing the fractions versus pH. In the use of these equations it may be observed that, when one measures a pH by potentiometric technique, the activity and not the concentration is obtained. From this standpoint the equations (17), (18) and (19) should hold well quantitatively.

These equations, like that of the Langelier index which follows, are useful examples of the value of the equilibrium constant.

Langelier Index

The Langelier saturation index was introduced in order to give a quantitative idea of the tendency of a given water to precipitate or dissolve $CaCO_3$. The index I is denoted as follows:

$$I = pH - pH_s \quad \ldots(20)$$

In (20), pH is the observed pH of the water and pH_s is the calculated pH at saturation with $CaCO_3$. If I=O, the water is stable. If I is positive, the water is oversaturated with calcium carbonate and tends to be deposit forming. When I is negative, the water is undersaturated with $CaCO_3$ and could tend to be aggressive.

The basic reaction is then one in which solid $CaCO_3$ film in a pipe would be subject to destruction:

$$CaCO_3 + H^+ \rightleftarrows Ca^{++} + HCO_3^- \text{ (film)}$$

The equilibrium constant, as in equation (13) incorporates the solid material:

$$K = \frac{(Ca^{++})\ (HCO_3^-)}{(H^+)} \quad (21)$$

At saturation (21) becomes:

$$K = \frac{(Ca^{++})\ (HCO_3^-)}{(H_s^+)}$$

Rearranging and taking logarithms:

$$pH_s = p(Ca^{++}) + p(HCO_3^-) - pK \quad (22)$$

Introducing the solubility product for $CaCO_3$ and the second ionization constant for carbonic acid,

$$K_s = \frac{(Ca^{++})\ (CO_3^=)}{(HCO_3^-)} \qquad K_2 = \frac{(H^+)\ (CO_3^=)}{(HCO_3^-)}$$

Substituting these expressions in equation (21),

$$K = \frac{K_s(CO_3^=)\ (H^+)}{K_2(CO_3^=)\ (H^+)} = \frac{K_s}{K_2} \quad (23)$$

Taking logarithm of (23) after simplifying,

$$-pK = pK_2 - pK_s \quad (24)$$

Substituting (24) into (22),

$$pH_s = p\ (Ca^{++}) + p\ (HCO_3^-) + (PK_2 - pK_s) \quad (25)$$

Equation (25) permits calculation of pH_s and, therefore, I if the calcuim and alkalinity and pH are known. The appropriate additional equations are (13) and (18). However, it is probably more customary to calculate the saturation index from prepared nomographs.[4] Like many other situations in engineering, prepared equations and nomographs may be more intelligently used and interpreted if their origin is understood.

Summary:

A number of examples of the important uses of elementary solution equilibrium chemistry have been cited in order to provide support for the conclusion that these concepts are deserving of greater emphasis in undergraduate and short course work in water and waste treatment.

References:

1. Glasstone, S. Textbook of Physical Chemistry. Chapter XI. D. Van Nostrand Co., Inc. (2nd ed. 1946).

2. Daniels, F. Outlines of Physical Chemistry. Chapter XVII. John Wiley & Sons, 1948.

3. Fair, G. M. & Geyer, J. C. Water Supply and Waste Water Disposal, Chapter 18. John Wiley & Sons, 1954.

4. Black, A. P. The Chemistry of Water Treatment. Water & Sewage Works, Reference & Date Edition, Vol. 96, No. 5. pR-69, (1949).

Red-Eye for Redstone Missiles Converts Missouri River into Highball

There were a lot of happy catfish in the Missouri River just below Kansas City the other day. More than 1,300 gallons of 190-proof alcohol were drained into the river by Columbian Steel Tank Company . . . deliberately, too.

They had a good reason (at least so they claim) for the dumping. The tank company was calibrating a Neptune Trident Meter, an integral part of the huge 3,000-gallon trailer tanks to be delivered under U. S. Government contract to the Redstone Arsenal in Alabama and two other locations. The semi-trailers transport part of the missile fuel (alcohol and water) used to propel the Redstone. Liquid oxygen is added at the launching site.

Why calibrate with alcohol? To be absolutely sure of accuracy, the identical formulation of alcohol and water used in the missile fuel recipe had to be used in the meter calibration. How accurate? Within *one-tenth of one per cent* . . . both input and output.

A Government "T-Man" was on hand for the dumping, to make certain that no alcohol was diverted . . . accidentally . . . to pocket flasks or gallon jugs for non-industrial use, such as medicinal. The 1,300 gallons, for example, might have been re-distilled and processed into gin. In this case, Uncle Sam would be out an extra few thousand bucks for end-use taxes. Reclaiming costs would make re-use of this mixture too steep economically, anyway. To avoid any possibility of river contamination, fire or explosion, the alcohol was carefully diluted with water as it was dumped.

At last report, a large school of catfish, not subject to the same tax regulations as people, was still milling about the Missouri at the spa now known as "Catfish Row".

HYPOCHLORINATION GUIDE

This is a series of articles being presented in four parts dealing with hypochlorite-chlorine materials and their use in environmental sanitation control. The various subjects that are being reviewed include: the nature, manufacture, storage and handling of hypochlorites; principles fundamental to hypochlorination processes, especially as they relate to municipal water supply, swimming pool and wastes treatment practies; and a discussion of hypochlorite feeding and dosage control equipment that facilitates their safe and effective application.

Writings on the subject are numerous and no single treatise is or can be complete by itself. These articles are not purported to contain all or even a majority of principles, facts or techniques relating to the subject. The information being presented is believed to be reliable and reflects the experience of many producers and consumers of hypochlorites, and of purveyors of equipment suitable for their handling. With regard to handling and safety suggestions, readers are cautioned that certain circumstances may warrant modified or additional procedure; moreover, cognizance must be taken of any Federal, state, municipal, insurance or other requirements that might apply.

Hypochlorination of Wastes

(Part III)

by EDMUND J. LAUBUSCH,
Technical Manager
The Chlorine Institute, Inc.,
New York, New York

Development

The application of hypochlorites to sanitary wastes preceded their use for disinfection of potable water systems. By 1830, about a half century before the germ theory of disease was established, the use of chloride of lime for deodorizing sanitary wastes had been advocated, and practiced to some extent, on the theory that the control of sewer odors would limit the spread of infection.

The earliest large plant-scale adoption of sewage chlorination (using chlorinated lime) is believed to have taken place in 1854 when the Royal Sewage Commission employed it to deodorize London sewage. By 1859, it had been demonstrated that the application of chlorinated lime to sewage substantially retarded its putrefaction, and the use of this material to minimize or control stream putrefaction was adopted in 1872 at Northampton, England.

The application of chlorinated lime specifically for the disinfection of infectious typhoid wastes was first practiced in England in 1879. In 1894, experiments on hypochlorite disinfection of partially treated sewage were made at Brest and Nice, France, and at Worthing, England. But it was not until about 1907, however, that the practice received much attention of American scientists. In that year, plant-scale studies of hypochlorite disinfection of sewage were undertaken by E. B. Phelps at Red Bank, New Jersey, marking the beginning of effective sanitary wastes disinfection in the U. S. The uses of chlorine and chlorine compounds for purposes other than odor control and disinfection only were recognized and adopted many years later.

There is a paucity of data on the early history of sewage treatment and chlorination in the U.S. during the first few decades of the 20th century. Published data indicate that only 22 of 619 waste treatment facilities (about 35 per cent) operating in 1910 employed chlorination (using commercial hypochlorites then available, largely chlorinated lime). Since that time, as indicated in Table 1, development has been steady, although not nearly as impressive as that pertaining to chlorination of water (See Part II).

Considerable refinement and progress has occurred during the past half century in the quality of commercial hypochlorites and feeding equipment.

Table 1.

Trend in Development of Community Wastes Chlorination in the U.S.*

Year	Treatment Plants			Estimated Population Served x 10 ⁶		
	All	Using Chlorine	% Using Chlorine	All Plants	Plants Using Chlorine	% Benefiting Wastes Chlorination
1910[1]	619	22	3.6	4.46	0.11	2.4
1916[1]	846	55	6.5	6.14	0.28	4.6
1934[2]	3697	655	17.7	22.20	—	—
1940[3]	5580	1127	20.2	40.62	14.34	35.3
1945[4]	5786	1262	21.8	46.86	16.03	34.2
1948[5]	6058	1307	21.6	48.70	18.04	37.0
1957[6]	7518	2216	29.5	76.44	37.84	49.5

*Data are not strictly comparable due to slight variations in statistical reporting and analytical procedures.

In its infancy, disinfection and odor control of sanitary wastes was accomplished by using either chlorinated lime (chloride of lime, bleaching powder, etc.) or sodium hypochlorite. Solution-feed equipment then available often yielded erratic results. Impetus to effective wastes chlorination came with the commercial availability of liquid chlorine (1909) and proprietary chlorinators (1912-1913); the proposal of a practical colorometric method for chlorine residual determination (1909) and its development and subsequent adoption; and, finally, the production (1928) of high-test hypochlorites containing 70% available chlorine.

Data on the relative amounts of liquid chlorine and hypochlorites used for wastes chlorination during the period 1910-1948 are not available. In 1948, of a total of 1307 community wastes treatment plants in the U.S. that had adopted chlorination for disinfection and/or other purposes, only about 8 per cent were using hypochlorites. By 1957, this was further reduced to about 6.4 per cent of all plants chlorinating (See Table 2).

Although hypochlorites are generally more useful and economical than liquid chlorine at smaller plants, a few larger plants also have adopted the material, especially in recent years (See Table 2). The use of hypochlorites in waste treatment, then, is by no means obsolete or diminishing in importance. As shown in Table 3, for the period 1948-1957, there was about a 40 per cent increase in the number of community wastes treatment plants using hypochlorites; those using liquid chlorine increased by about 80 per cent during the same period. However, on the basis of contributing population, this represents an increase of 144 per cent versus 110 per cent for hypochlorites and liquid chlorine, respectively.

Treatment Principles

Normal sanitary and industrial wastes are about 99.9 per cent water. The balance represents a large and complex variety of suspended and dissolved inorganic and organic materials, sometimes in addition to large numbers and varieties of bacteria, protozoa and other organisms. These materials have an effect on wastes chlorination practices similar to that which they have on water chlorination practices. Moreover, their frequently greater numbers, variety and complexity make them even more significant in the establishment of a chlorination regimen suitable for treatment objectives. Because hypochlorites and chlorine-containing compounds are strong oxidants, they are rapidly dissipated in various reactions with many of these materials —an especially important consideration where disinfection or nuisance organism control is the treatment objective.

When high-test hypochlorites (or sodium hypochlorite) are added to liquid wastes, immediate ionization occurs:

$$Ca(OCl)_2 + H_2O \rightleftarrows Ca^{++} + H_2O + OCl^-$$

Hypochlorite ions (OCl^-) establish an equilibrium with hydrogen ions, thus:

$$OCl^- + H^+ \rightleftarrows HOCl$$

The amount of OCl^- and HOCl in solution is a function of pH. Between pH 6.0 and 8.5 there occurs a very sharp change from undissociated HOCl to almost complete dissociation. Thus, chlorine exists predominately as HOCl at low pH levels; above about pH 7.5, OCl^- predominates and exists almost exclusively at pH 9 and above (See Part II, Fig. 1).

The conditions described do not ordinarily persist for any appreciable time.

Because of their oxidative capacity, free available chlorine forms (such as HOCl and OCl^-) begin to react immediately with many constituents normal to most wastes, forming a variety of other chlorine compounds. For example, chlorine in solution reacts with inorganic and organic nitrogen-containing impurities in wastes to form inorganic chloramines (primarily monochloramines and dichloramines at normal pH levels) and organic chloramine complexes. The oxidation potential and disinfecting capacity of these combined available chlorine forms, especially organic chloramines, are considerably less than that for free chlorine forms. Chlorine reacts also with inorganic materials to form chloro-addition or chlorine substitution complexes. Each of these various chlorine-consuming reactions occurs at different rates and exert a chlorine demand which must be satisfied before (or simultaneous with) significant disinfection is accomplished.

Chlorine forms that are able to penetrate cell membranes and cysts or spore walls are believed to react with an enzyme system essential as a catalyst for metabolism. It also is believed that HOCl exhibits substantially greater ability than OCl^- to penetrate cell membranes and destroy essential enzymes, and that dichloramines are more effective than monochloramines, organic chloramine complexes and other possible chlorine forms in producing these effects. These theories currently are used to describe the basis of wastes disinfection.

The literature contains little and conflicting information on the relative efficacy of liquid chlorine and hypochlorite chlorine in wastes disinfection. Regardless of the form in which chlorine is applied, the same chemical equilibria are believed to be established.[7] The relative amounts of HOCl and OCl^- formed depend on the pH of the waste *after* the chlorine is added. The addition of a solution of chlorine gas tends to lower pH (due to hypochlorous and hypochlor-

Table 2.

Distribution of Use of Hypochlorites and Liquid Chlorine For Sanitary Wastes Chlorination in the U.S. (1948 and 1957)[5, 6]

Population Group Served	Number Plants Chlorinating (Min.)						Est. Pop. Served x 10^3					
	Total		Hypochlorites		Liquid Chlorine		Total		Hypochlorites		Liquid Chlorine	
	1948	1957	1948	1957	1948	1957	1948	1957	1948	1957	1948	1957
Under 500	73	146	17	40	41	82	36.5	80.5	5.9	12.0	24.7	55.9
500- 1,000	171	246	30	40	96	166	114.0	182.3	15.1	26.5	70.8	128.9
1,000- 5,000	580	921	49	51	391	674	1,314.2	2,177.4	60.1	86.2	925.0	1,619.3
5,000- 10,000	186	340	4	3	108	244	1,186.3	2,365.2	22.7	17.8	674.2	1,763.7
10,000- 25,000	166	292	3	6	125	218	2,189.8	4,082.9	25.2	72.0	1,654.0	3,041.2
25,000- 50,000	60	127	0	0	51	95	1,862.9	3,991.9	0	0	1,643.5	2,956.1
50,000-100,000	24	54	0	2	18	38	1,317.4	3,366.0	0	100.0	1,175.5	2,546.8
Over 100,000	47	90	0	0	36	67	10,015.6	21,589.1	0	0	7,980.5	15,563.4
Total	1307	2216	103	142	866	1584	18,036.7	37,835.2	128.9	314.5	13,149.1	27,675.3

ic acids formed); whereas, the addition of hypochlorites (due to alkilinity excess) tends to raise pH. Many wastes are well buffered and the effect on pH may be insignificant. Sawyer[8], for example, has observed that the addition of 10 mg/L hypochlorite chlorine had little or no effect on pH of a relatively poorly buffered sanitary waste, but that the addition of an equivalent amount of chlorine water solution depressed the pH of the same waste significantly. In theory then, the addition of equivalent amounts of liquid chlorine (in solution) or hypochlorites should not be expected to yield equivalent results unless the amounts added are so small that the pH of the waste to which they are applied is unaffected.

Oxidation reactions with chlorine are reportedly[8] enhanced by low pH that prevails when liquid chlorine is the disinfectant of choice. (This may account for the greater chlorine demand sometimes observed than when hypochlorites are employed.) Chlorine consumed by these reactions may yet be available for disinfection, but the potency of the compounds formed is of low magnitude. Moreover, the type and amount of chlorine residual formed differs accordingly, depending on the form in which chlorine is applied. For these reasons, Sawyer contends that lesser amounts of hypochlorites than liquid chlorine may be needed to accomplish equivalent results and a lesser chlorine demand may be anticipated.

Additional research is indicated to clarify the relative disinfecting efficacy of liquid chlorine and hypochlorities in wastes treatment. It is abundantly clear that wastes disinfection is a complex subject and that the numerous germacidal chlorine derivatives which can be formed all differ in effectiveness[9]. Also, because of variations and fluctuations in quality of a specific waste, and because of differences in reactions that occur when different forms of chlorine are applied, the chlorine derivatives formed (and consequently, the chlorine residual) vary greatly. The real significance of the extent to which these and other factors affect wastes disinfection and other chlorination processes remains to be fully established.

Other Applications

Chlorine and hypochlorites have been employed quite effectively for a number of years as an aid to coagulation, especially for treating water high in color, iron or organic content. The primary value of chlorine in this connection is its oxidizing power. Many sanitary and many industrial wastes are devoid of oxygen and it frequently is expedient to supply chlorine with chemical precipitation. This is especially applicable when coagulating with iron salts, for in the absence of oxygen ferric iron generally is reduced to the ferrous form having little or no precipitating value. Chlorine and its products are similarly capable of precipitating proteins and fats, a property which makes their application especially suitable in treating industrial wastes (such as those from meat packing houses) that contain large amounts of protein, grease and fat materials.

Thus the utility of chlorine and hypochlorites in wastes treatment is based on oxidative capacity and toxicological characteristics. Any decrease in oxidation potential of chlorine reduces the rate at which reactions with impurities proceed, and also diminishes the bactericidal effect. The amount of chlorine required to carry reactions to an equilibrium at any given time interval is a function of the temperature, pH, concentration and type of oxidizable and chlorine-absorbing materials. The speed and completeness is governed by the law of mass action. Thus, the concentration of chlorine, chloramines and oxidizable substance also affects the mechanism of the reactions and the types of end-products formed. In some cases, oxidation reactions proceed slowly even under optimum conditions of temperature, pH and concentration of reacting substances, and an appreciable time period may be necessary to establish equilibrium. The extent to which biological destruction or attenuation occurs depends on similar factors.

Use with Sanitary Wastes

Chlorine has been employed effectively in one or more steps of practically all conventional wastes treatment processes. A large number of sanitary wastes treatment facilities employ chlorine or hypochlorites continuously for odor and septicity control, BOD reduction, as a coagulant or coagulant aid, or for partial or complete disinfection. Intermittent applications for relieving filter ponding, psychoda problems, sludge bulking, slime and algae control and numerous others, also are popularly employed.

Both liquid chlorine and hypochlorites are effective for these various purposes. Hypochlorites are popularly employed by small plants (See Table 2) and for emergency use by a number of large plants. Moreover, they are especially effective for those

Table 3.

Per Cent Change in Relative Use of Hypochlorites and Liquid Chlorine For Sanitary Wastes Chlorination in the U.S. (Between 1948 and 1957)

Population Group Served	Approximate Per Cent Increase					
	Plants Chlorinating			Est. Pop. Served		
	All	Hypo-chlorites	Liquid Chlorine	All	Hypo-chlorites	Liquid Chlorine
Under 500	100.0	135.2	100.0	120.5	103.2	125.3
500- 1,000	43.8	33.3	73.0	59.9	75.5	82.1
1,000- 5,000	58.8	4.8	72.4	65.6	41.8	75.0
5,000- 10,000	82.8	(25.0)	126.0	99.5	27.5	161.5
10,000- 25,000	76.9	100.0	74.3	86.5	185.5	83.7
25,000- 50,000	111.5	—	86.3	114.2	—	79.9
50,000-100,000	125.0	∞	111.0	155.8	∞	116.8
Over 100,000	91.5	—	86.2	115.7	—	95.0
Total	69.6	38.9	82.9	109.7	144.1	110.2

many treatment processes or applications which require only occasional or intermittent chlorination, regardless of volume of wastes involved. Ofttimes their use in such instances eliminates the need of costly equipment and minimizes possible objectionable handling, storing and safety problems associated with some other chlorine forms. They are especially adaptable at institutional, restaurant, camp and similar facilities where relatively small volumes of waste are involved and where ease and simplicity of operation is essential[10, 11]. Within recent years they have been used for treatment of cabin cruiser wastes[12].

Sodium hypochlorite generally is more expensive than high-test calcium hypochlorites and is somewhat less conveniently handled. For these and other reasons, it does not enjoy the popularity of high-test hypochlorites in wastes treatment. However, it does have the advantage of producing considerably less sludge in most applications, and where this is a significant factor, its preference is clearly indicated.

Hypochlorites are applied at upsewer, in-plant or in-stream locations wherever maximum benefit, consistent with the treatment objective, is afforded.

Use with Industrial Wastes

Many industrial wastes are separately treated by the same physical, chemical and/or biological processes commonly employed for treating community wastes. The various uses of chlorine and hypochlorites associated with such processes—odor and septicity control, oxidation, BOD reduction, improved biological filter and activated sludge operation, coagulation, sludge thickening, etc.—are equally applicable to many industrial wastes. Frequently treatment units for handling industry wastes are of much lesser capacity than those required for handling a community's wastes, and hypochlorite chlorine forms may be especially suitable, particularly where treatment is on an intermittent or seasonal basis. They frequently are used to retard septicity, fermentation, slime growth and other undesirable conditions where wastes are temporarily stored pending controlled discharge into a community wastes and receiving system and in transit to the treatment site.

The choice between liquid chlorine and hypochlorites also depends on the methods best adapted to the problems at hand, equipment and installation required for each, concentration of impurities in the waste, variations in the quality and quantity of wastes to be treated, availability and cost of chemicals etc.

The alkaline-chlorination process (batch-type or continuous) is the most commonly employed means of treating cyanide-containing metal processing and refining wastes. Hypochlorites are as effective as liquid chlorine for cyanide oxidation, but the use of high test hypochlorites is sometimes not advantageous because of the large quantities of sludge produced. Hypochlorites are used to some extent, however, particularly where small volumes of wastes are produced. Phenols, too, can be effectively oxidized by hypochlorites, but chlorination must be complete to prevent formation of chlorophenols. Possibly because of the frequently high chlorine demand of phenol-containing wastes, hypochlorite chlorination treatment does not appear to be extensively employed.

Wastes from wool scouring plants are among the strongest and most objectionable of industrial processing wastes. The treatment of such wastes with liquid chlorine was suggested about 1918 and, although a process was patented in the U.S. about 1925, it has never been used commercially. About 1946 a process utilizing calcium hypochlorite for treating wool scouring wastes was developed. Reported by Faber[13], it involves addition of hypochlorite to destroy the emulsified nature of the wastes; the combination of oxidation and coagulation reactions provides good separation of colloidal and suspended solids, and permits easy recovery of wool grease precipated as insoluble soaps. Hypochlorination of wool-scouring wastes is employed at some textile mills.

As noted previously, the efficiency of chlorine as a primary coagulant also permits precipitation of protein and fats typical of meat packing industry wastes. Hypochlorite application (pretreatment) for septicity control, and in-plant application for coagulation is adaptable to treatment of such wastes from smaller packing houses.

Food processing wastes generally contain such a high amount of chlorine-consuming organics that chlorine treatment alone is prohibitively expensive. As an adjunct to other treatment processes for odor control, retardation of septicity, algae etc., hypochlorites are sometimes employed by canning and other food processing industries. Reinke[14] for example, reports that application of sodium hypochlorite at a rate of 20 mg/L is sufficient to destroy odors often associated with land irrigation disposal of milk products wastes.

The problem of reusing beet sugar waste waters in plant operations may be improved by adding hypochlorites to the fresh waters to reduce undesirable fermentation products. The treated waste water should show a residual of 1 to 1.5 mg/L after 10 min. contact.

Recirculation of process waters by many industries, such as white waters in the paper industry, oil refinery

waste waters, condensor and cooling waters and others is possible if slime and other nuisance organsims are controlled. Hypochlorite chlorine forms are especially suitable and are frequently employed for this purpose.

Operational Control

In employing chlorine or hypochlorites in wastes treatment, care must be excersized to select the point (s) of application and dosages in such a manner as to accomplish the objective as efficiently as possible without interference to biological or other chlorine-sensitive processes. Flexibility in operation should be provided.

The considerable variations in the chemical and biological make-up of wastes preclude the establishment of rigid, uniform chlorine residual requirements. The value of maintaining a specified chlorine residual is based principally on demonstration of the effects of such practice on the desired objectives, and conformance to limiting requirements on the quality of the wastes effluent or the receiving water. For disinfection and other purposes, hypochlorination control is practically attained by routine chlorine residual determinations; for some purposes, control is based on a percentage reduction of total chlorine requirement. The chlorine requirement is defined as that amount of chlorine, in mg/L, which must be applied to produce a residual of such strength that, after a definite contact period, the effluent will show a desired coliform density or will meet the requirements of some other treatment objective.

Some applications involve less control and are less susceptible to quality fluctuations and variable chlorine requirements. Or, the treatment regimen may be a preventive, rather than a curative one. In such cases, the application of fixed amounts of hypochlorites in accord with a suitable schedule may suffice, and the effectiveness of treatment may be based on the absence of algae or odor, or on some other simple operation parameter.

References

1. Porges, R. "United States Sewage Treatment Practices During the Early Twentieth Century," *S. & I. W. Jour.* 29:12, 1321 (12/57)
2. Anon., "Sewage Treatment Facilities in the United States," *Eng. News-Rec.*, 115:7, 224 (8/15/35)
3. Anon., "A Summary of Census Data on Sewage Systems in the United States," *Public Health Reports*, v. 57,12 (3/20/42)
4. Thoman, J. R. "Statistical Summary of Sewage Works in the United States," *Public Health Reports*, (4/50)
5. Thoman, J. R. "Statistical Summary of Sewage Chlorination Practice in the United States," *S. & I. W. Jour.* 22:9, 1128 (9/50)
6. Thoman, J. R. and Jenkins, K. H. "Statistical Summary of Sewage Chlorination Practices in the United States," *S. & I. W. Jour.* 30:12, 1461 (12/58)
7. Moore, E. W. "Fundamentals of Chlorination of Sewage and Industrial Wastes," *Water and Sewage Works*, 100:5, (5/53)
8. Sawyer, C. N. "Hypochlorination of Sewage," *S. & I. W. Jour.* 29:9, 978 (9/57)
9. Hess, S. G., Diachishin, A. N. and De Falco, P. "Bactericidal Effectiveness of Sewage Chlorination," *S. & I. W. Jour.* Part I, 25:7, 751 (7/53); Part II, 25:8, 909 (8/53)
10. Heicken, K. "The Disinfection of Infectious Sewage," *Zbl. Bakt.*, I, 165,156 (1956)
11. Anon., "Sewage Plant For Restaurant Treats 12,000 gpd.," *Public Works*, 89:3, 98 (3/58)
12. Ingram, W. T. "An Investigation of the Treatment of Cabin Cruiser Wastes," *S. & I. W. Jour.* 28:1, 93 (1/56)
13. Faber, H. A. "The Hypochlorite Process for Treatment of Wool Scouring Wastes and for Recovery of Wool Grease," *Sewage Works Journal*, XIX:2,248 (3/47)
14. Reinke, E. A. "Prevention of Odor Nuisance in the Disposal of Creamery Wastes with Chlorine Preliminary to Broad Irrigation," *Calif. Sewage Works Journal*, 1:3 (1928)

Maryland Publishes Costs of Water Needs

The water and sewage system construction in Maryland communities, estimated to cost nearly $44.2 million, was labeled "urgent" by State health officials who placed the cost of meeting the long-range demands of a "zooming" population at almost $267 million.

These forecasts were made public in reports compiled by the Maryland State Legislative Council's committee on taxation and fiscal matters, which was surveying the financial needs of local government units and the overall fiscal relationship between the State and its sub-divisions.

The State Health Department said that the City of Baltimore needs water improvements which would cost $10 million in less than five years, $30 million additional within ten years, and $60 million in the long-range future.

Under Maryland law, the Department is responsible for enforcing the installment of adequate water systems. In recent years, it has made its program more stringent.

Although the dollar volume for Baltimore was by far the most formidable, the reports to the Committee presented serious problems for many communities having less resource to draw on. The reports called for 32 completely new water systems, most of them in small communities presently without service.

Baltimore County's water system requirements for the immediate future were minimum at $100,000 and only $800,000 for the next ten-year period; however, these costs jumped to $8 million in the long-range estimate.

Rand Joins Syracuse U. Faculty

Dr. Myrton Cook Rand has joined the faculty of the Civil Engineering Department of Syracuse University this September. He will serve in the capacity of Associate Professor in the graduate and research programs in Sanitary Engineering.

Dr. Rand received both his Bachelor's and Master's degrees from the University of Wisconsin and received his Doctor's degree in Sanitation from Rutgers University in 1956. After teaching at Rutgers for two years, Dr. Rand was Chief Chemist of the Middlesex County Sewage Authority in New Jersey. He has been in that position for the last three years. He authored many scientific papers on the subject of B.O.D., polarography, algae, surface reaeration, and chemical coagulation.

Before you ask him for a raise, better let me see which way the wind is blowing.

Pennsylvania Section of the American Water Works Association Meeting discussed . . .

Urban Redevelopment and Thermal Discharge

by R. W. Simpson*,
Chief Sanitary Engineer
W. A. Garlow, Asst.,
Gilbert Associates, Inc.

Editor's Note: Presented here are abstracts of some of the highly informative papers presented at the Pennsylvania Section A.W.W.A. meeting held at Pittsburgh, June 14-16, 1960.

Effect of Urban Redevelopment on a Water Department by John Mauro, Urban Renewal Co-ordinator, Pittsburgh, Pennsylvania. Mr. Mauro pointed out that the growth of Pittsburgh has been chaotic over 200 years. In the past homes were built close to the mills and as people prospered along with the increased usage of the automobile, the people moved away from the mills. As a result 28 per cent of this housing became blighted or slum areas. In addition, this housing in the past has prevented industrial expansion. As a result the Urban Redevelopment Authority was created in which the Commonwealth of Pennsylvania participated along with the City of Pittsburgh.

One of the first projects undertaken for Urban Renewal was the Golden Triangle area of Pittsburgh and the attention of the members attending the Convention was directed to the excellent results.

In the Golden Triangle area all of the distribution facilities had to be revised. However, as a result of the rehabilitation of this area the water consumption has increased four times over which existed when it was a slum area.

In order to keep pace with this Urban Redevelopment Program, the City of Pittsburgh has converted all of the coal burning water pumping stations to electricity, constructed a 2 million gallon reservoir, a new raw water clarifier at the filter plant and rehabilitated sections of the distribution system.

It was pointed out that once the City of Pittsburgh undertook their Urban Renewal Program, private industry within the City also undertook a considerable renewal program on their own initiative. Although the Urban Renewal Program for the City of Pittsburgh is for that area within the legally defined limits of the City, it was impossible to undertake this program without collective planning with the surrounding communities. The Allegheny County Sanitary Authority is a good example of this type of planning. There must be a regional solution to all of the problems, to make urban renewal successful.

In addition, it is ridiculous to postpone capital improvements as these improvements will only cost more in years to come.

Establishing a Management Training Program in Pennsylvania was reported by John H. Murdoch, Jr., Bryn Mawr, Pennsylvania. The training program will be for personnel from both the large and small water utilities and the purpose is to help alleviate the shortage of trained management personnel that is rapidly developing in the water utility industry.

The management training program will be for one day or more a week in various locations throughout the State of Pennsylvania. The proposed method of presenting this management training program will be the case history method.

All members of the Pennsylvania Section were requested to participate in this training program.

Thermal Pollution was discussed by Gerald E. Arnold, Philadelphia Water Department. Thermal pollution is mainly due to the discharge of cooling water to the streams by steam power plants and steel plants, wherein the temperature of the stream is increased with a deleterious effect on the fish and biota in the streams. The interesting thing about this thermal pollution, however, is that it is not a permanent type of pollution in the streams in that it dissipates itself in time.

As a result of this problem, the Sanitary Water Board, Commonwealth of Pennsylvania, has appointed a committee, on which Mr. Arnold is the Chairman, consisting of representatives from industry, sportsmen associations, health department and municipalities, to study the problem. The committee is then to recommend to the Sanitary Water Board standards to govern the discharge of cooling water in the Commonwealth.

If the steel industry were required to build cooling towers for treatment

*Contributing Editor W & S W

of cooling water prior to discharge to the streams, this requirement would cost the steel industry an estimated 40 million dollars in construction cost and an annual cost of 10 million dollars for operation of these facilities. The steel industry in Pennsylvania is also faced with an additional problem in that only one mill in Pennsylvania has sufficient land on which to construct cooling towers. Therefore, there is a problem in obtaining sufficient sites for any cooling towers required.

It has also been estimated that the cost of construction and operation of cooling towers for the steam power plants in Pennsylvania would be the same as that mentioned above for the steel industry.

It was pointed out that the estimated costs involved for these two industries for cooling towers is a very serious problem when one considers the economic implications and the competitive position that exists today between states for new industry.

When the committee began to study this problem of thermal pollution, they found out that there is a considerable lack of basic data. The only information the committee was able to obtain was information from a study that had been made on one power plant discharging cooling water at Martinscreek on the Delaware River.

In addition, the committee recognized the fact that deep running narrow streams are not influenced in the same manner as wide, shallow streams, by the discharge of cooling water.

Therefore, the committee is faced with the tremendous task of obtaining sufficient data on streams and cooling water discharge from which to make their recommendations to the Sanitary Water Board. The steel companies and two of the power companies in the greater Pittsburgh area have already set up a study group on this problem on the streams in this area.

It was requested that all members present assist this committee by obtaining basic data on the streams at their water plants, submitting this data to the committee for study. The data the committee is interested in is temperature and dissolved oxygen content at various depths and horizontal locations across the width of the streams, as well as data on cooling water discharged to the stream upstream from the filter plants.

The members of the American Water Works Association were urged to participate in this voluntary study during the summer and winter months in the forthcoming year. This data is very essential to the committee in order that logical recommendations may be made to the Sanitary Water Board.

Radioactive Wastes and Their Control in Pennsylvania Waters, was reported by Walter A. Lyon, Pennsylvania Department of Health.

Radioactivity in Pennsylvania Waters may occur from three sources: natural background—leaching from the soil; fallout; and radioactive wastes discharged. The greatest amount of radioactivity in the past few years has occurred from fallout from nuclear tests. Waters of the Commonwealth have shown a reduction in radioactivity during the first few months of 1960, due primarily to reduction in fallout since the cessation of nuclear testing. The radioactivity of waters of the Commonwealth is less than the average for all rivers in the United States. The greatest concentration in the United States appears to be in Western rivers, closer to nuclear testing sites, and where the naturally occurring radioactive ores are greater in quantity.

The Sanitary Water Board of Pennsylvania, through the Department of Health Staff, carefully screen applications for permits to discharge radioactive wastes to streams of the Commonwealth, thus affording protection for the citizens of the State.

Pre-operational monitoring surveys are required in the vicinity of proposed sites where radioactive wastes may be discharged, to obtain background data.

The standard established by the National Committee for Radiation Protection for discharge of liquid wastes to streams used for public water supplies is applied to applicants for permits to operate. Accordingly, for any unknown mixture of isotopes, the discharge may not exceed 10^{-8} microcurries per milliliter above natural background. The permittee is allowed only a fraction of the low stream flow for dilution purposes.

While the standards may appear strict, the State feels justified by the fact that our knowledge of the effect of low levels of radiation upon humans is very limited.

Research at the University of Pittsburgh to determine the effect upon aquatic life in the Ohio River, due to the discharges from the Shippingport Reactor indicates that significant increases in radioactivity due to fallout and not to radioactive wastes discharges from the reactor, has occurred.

Some radioactive waste is discharged to sewage systems, rather than directly to surface waters. It appears that in such cases sewerage systems provide sufficient dilution to produce a safe concentration at the treatment plant.

A program was initiated in the summer of 1959 for sampling typical Pennsylvania water works in order to determine the levels of radioactivity in raw and finished waters. The waters were found to be generally well below the maximum levels recommended by the National Committee for Radiation Protection.

The Department of Health plans on expanding its program for sampling of streams in the Commonwealth in order to build up a better picture of stream conditions, among which will be checks for radioactivity.

Occurrence of Manganese in the Allegheny River Basin was the subject presented by R. B. Adams, Wilkensburg—Penn Joint Water Authority. He reported on the preliminary findings that Mr. George E. Whetstone, U. S. Geological Survey, and himself have obtained.

Their data compared the chemical qualities of water in the Allegheny River Basin in 1900 with that found today. One important point made by Mr. Adams was that the Number 1 problem in 1900 is not the Number 1 problem in 1960. Today, it is the problem of manganese in the basin, whereas in 1900 it was muddy water with pollution.

It was pointed out that as a result of the study of the manganese problem, they found an industry which was contributing a considerable amount of manganese to the basin. As a result this has now been voluntary alleviated by the industry.

Safety at Work a panel discussion, was part of the Program, directed

to the waterworks operators. Paul Burdan, American Water Works Service Co., discussed a "Do It Yourself" program.

The accident frequency in the water works industry is quite high, exceeded only by coal mining, lumber and marine transportation. This appears to be due to a disinterested attitude on the part of water works personnel. The basic causes for accidents in the water works field appear to be lack of conviction that safety is necessary, indifference and insincerity.

What are the methods of overcoming the bad safety record of the water works industry? Employees may be ordered to improve their safety record. The economics of a poor safety record may be pointed out, and provide very convincing arguments in favor of safety programs. Many individuals, knowing the results of accidents, may sincerely want to prevent accidents.

While direct orders, or economics of safety may provide a good start towards a better safety program, the individual must be convinced that the prevention of accidents is his moral obligation, and to work accordingly, if the water works industry is to improve its record.

How It Is Done was covered by John F. Kegebein, Philadelphia Suburban Water Company. Since most accidents are caused by carelessness, they could be prevented. Any water works industry, regardless of size, could benefit from a planned safety thinking and training program.

An individual, or several, must be appointed the responsibility agent for the industry's safety program to initiate it, and carry the program forward. One plan used successfully was to set up a management safety committee, with the supervisor of each department responsible to the committee.

Safe handling of chemicals at the filter plant is one place to start. Proper truck unloading, handling of pallets by fork lift trucks, and proper storage is much safer than hand unloading and trucking to storage. Dust removal equipment is a necessary safety precaution. Other safety measures at the filter plant include exhaust fans, adequate lighting, safety switches, explosion-proof electrical wiring and equipment, safety showers, well planned exits, and safety clothing and equipment.

Even with all the necessary safety precautions, accidents occur due to indifference. It is the workman's problem to promote safety—a matter of self-preservation.

The Importance of Safety in the Small Water Utility was discussed by Harry J. Borchers, Jr., North Wales Water Authority. Safety is taken for granted in the small water utility, perhaps because the superintendent or manager is too close to the job, or because he hears little about major accidents, nor is he exposed to them. The accident rate in small water works is exceedingly high, as a result. The real reason appears to be lack of concern for safety.

Neatness, courtesy and common sense are prerequisites for safety, as well as efficient operation and good public relations.

A small water utility is hurt much more by lost time accidents than a large one, since the injured employee may be 50 per cent of the work force, may be the only trained man for certain jobs, and may cost the utility considerable expense.

Organizing For Safety by John T. Cappio, Safety Engineer, Philadelphia Water Department. Enlisting the support of all personnel to attain the goal of preventing accidents, is the key to organizing a safety program.

There are certain basic elements needed to make a safety program a success. Management must be convinced that a safety program is needed and give its active support. One individual should be given the responsibility for safety activities, whether he be a safety engineer in a large organization or even a foreman in a small utility. The responsible man must be able to eliminate physical hazards and unsafe working conditions and recommend safe practices to other employees.

When planning new work, hazards should be eliminated on the drawing boards; safety should be designed and built with the job, not added after.

Safety training is necessary to educate and motivate the employees. Employees must understand the company's policy on safety, and accept the responsibilities inherent in it. Employee interest is important to the safety program.

Accident investigation and records are important, in order to remove the cause and prevent reccurrence.

Medical and physical examination of all new employees, and periodic examination of older employees, is necessary in order to assign work which an employee is capable of doing, without fear of accident.

Just as the other speakers stressed the mental attitude towards safety, in terms of indifference, Cappio also feels that employees must be conditioned to want safety—in order to reduce the water industry's accident rate.

Design Requirements for Prestressed Concrete Pipe by Robert E. Ball, Lockjoint Pipe Company. As a result of Specification A.W.W.A.-C301, a standardized design procedure has been developed for prestressed concrete pipe. It is now possible for engineers to check design data on prestressed concrete pipe irrespective of the manufacturer.

This design procedure has been based on results from laboratory testing which has been more rigid than those conditions encountered in an actual field installation for prestressed concrete pipe.

Shakedown of the Torresdale Filter Plant by John A. Dillener, Philadelphia. The operation of the Torresdale Filter Plant was described by the use of slides prior to the discussion of the problems encountered.

In addition, the author reviewed the program that was established prior to operation of the filter plant wherein the normal problems of operation arose.

Considerable time and effort was spent prior to operation of the plant on establishing a table of personnel organization. The problems involved in obtaining approval of new job classifications that were non-existent prior to operation of the Torresdale plant were disclosed. In addition, the training program that was established for all personnel at the filter plant was presented. Inherent with developing the training program was the establishment of standard operating and preventative maintenance procedures.

The operating problems that arose during shakedown were; valves installed in the pipe gallery upside

down; lightning striking the main transformer; compressed air equipment insufficient in capacity; check valve slamming on wash water pump; altitude valve on wash water tank operating improperly; failure of air controls on filter wash cycle wherein 10 inches of sand was lost; problems with lime slakers and screw conveyor; sludge draw-off line from sedimentation basin clogged after 6 months operation; improper operation of wash water valves and rusty water complaints.

The cause of all these unique operating problems listed above and the necessary steps required to remedy the problems were pointed out.

The importance of automation in water treatment plant operation and the ever increasing importance of this method in the future was discussed.

A Work Shop session was conducted by leaders Walter C. Christopher, V. A. Appleyard, James W. Myers, Jr., K. C. Armstrong and Dr. C. W. Fifield.

Some of the items discussed in Work Shop under **Efficiency in Office Practice** were types of payroll forms used by various water utilities, methods of handling consumer complaints, sewer billing practices and types of office layout for efficiency. Under the subject of **Cleaning and Relining Water Mains,** some of the results obtained in Philadelphia were pointed out to the group. Philadelphia has spent 2.2 million dollars for cleaning and relining of mains and has found the results most beneficial. Relining mains has resulted in increased carrying capacity, reduced pumping costs, and reduced red water complaints. Cleaning and relining of mains in Philadelphia has also delayed the day when it will be necessary to install reinforcing mains. The City of Philadelphia has set up a definite method of studying a given main to determine whether or not they should clean and reline the main or whether the main should be replaced.

Meter Cleaning, Testing and Repairing brought out the fact that each water utility has problems unique in themselves and therefore no ground rules could be established that would be applicable for meter testing. It was pointed out that the P.U.C. in Pennsylvania has established rules for private water utilities. The discussion brought out the fact that the most popular meter testing period in general use is 5, 7, or 10 years. The quality of the water is all important with respect to establishing a test period for meters. Methods of field testing meters and methods of cleaning meters during inspection were also reviewed.

Adequate Maintenance in the Water Plant pointed out that cleanliness of plant and maintenance of grounds is most important from a public relations standpoint and also plant operator's morale. Methods of painting various types of surfaces were reviewed. Light and heavy maintenance in a plant requires a written record be maintained. Also, all equipment failures must be recorded. It is most important that equipment manuals be available to the people who do the repair work.

Bacteriological Methods brought out the fact that the membrane filter technique has been accepted by the committee and will be a standard alternate in the latest edition of Standard Methods. Pennsylvania Department of Health has accepted this method provided the laboratory using it has been approved by the Health Department. The membrane technique is a more precise method as it is a direct count method and not a statistical method. In addition, results are obtained in 18 hours versus the 96 hours required by the MPM method. Research is progressing on a new media that will last longer for use with the membrane technique. An interesting question brought up during this discussion was how do you report on a well when a bad sample is obtained? Dr. Fifield brought out the fact that more than a test is required; all physical and environmental conditions must also be considered. The sample should be reported and not the well.

All leaders of this Work Shop stressed two things in summarizing the discussions. They are that the Work Shop method is an excellent method for dissemination of information to the members and secondly in using this method sufficient time must be allotted to do justice to the subject material under discussion.

5th International Water Supply Congress in Berlin

The International Water Supply Association will hold its Fifth Congress in the new Congress Hall in West Berlin from May 29 to June 3, 1961.

This Association was formed in 1949 and held its first Congress in Amsterdam. The following triannual Congresses were held in Paris, London and Brussels. Presently, twenty-seven countries are members of the Association including the U.S.S.R. Twenty-two more countries participated in the previous Congresses.

The work schedule of the Congress includes a general international report on each of the following seven topics: Water Disinfection, Pollution of Surface and Underground Waters, Water Metering and Water Meters, Statistical Analysis, Automation, Problems of Local and Regional Water Supply Systems and Large Diameter Pipes.

Harry A. Faber of the U. S. Public Health Service is the General Rapporteur of Subject No. 1; John W. Cramer, James G. Carns, Jr., Prof. John C. Geyer, Victor A. Appleyard, E. Sherman Chase, John C. McFarland, and H. Arthur Price are the national rapporteurs from the United States. The United States, however, is not yet a member of the I.W.S.A.

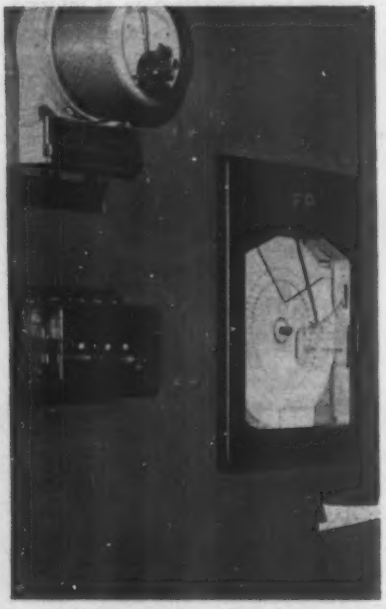
There will also be an International Exhibition of equipment and services used for the purposes of public water supply.

They retired him and the old sewage plant at the same time—so he brought it with him.

Magnetic Flowmeter Fills The Bill For New Jersey Community

■ AS THE LARGEST of a group of small towns bordering one another in west-central New Jersey, Gloucester City has utilities that are closely intertwined with those of its ajoining communities. Not the least complex of these utilities is its sewage disposal plant, which is now being used to process all the raw sewage (300,000 gallons per day) from nearby Westville. But Gloucester City's Sewage Plant is not of interest because of this fact alone, but rather because the billing for sewage treatment is based on "obstructionless flowmetering".

To give a brief background, the "Gloucester City Sewage Plant, which opened in October 1951, was designed to fill the needs of a growing community as projected 30 years ahead. Therefore, the plant's maximum capacity was not in use in January 1959, when Westville officials inquired about the possibility of Gloucester City processing their sewage.



F&P RECORDER at the Gloucester Plant records and totalizes raw sewage influent within an accuracy of ±1%.

Westville's own plant, then 50 years old, had been condemned by the state, and either a new plant or a working agreement with a nearby town was urgently needed. Westville, pursuing the latter course, found neighboring Gloucester City quite receptive to its proposal. The agreed-upon sewage treatment plan offered Gloucester distinct advantages—its reserve facilities would be utilized and additional revenue would be provided.

Now, only the "details" remained to be worked out; these "details", however, proved to be extremely challenging.

For billing purposes, the amount of raw sewage influent from Westville would have to be accurately measured. This, so it seemed, meant the installation of flowmeters which would impose operational problems since the sewage would have to pass through constrictions, thereby increasing pumping costs. These constrictions apparently would also make flushing and purging devices and cleaning and sediment tanks necessary.

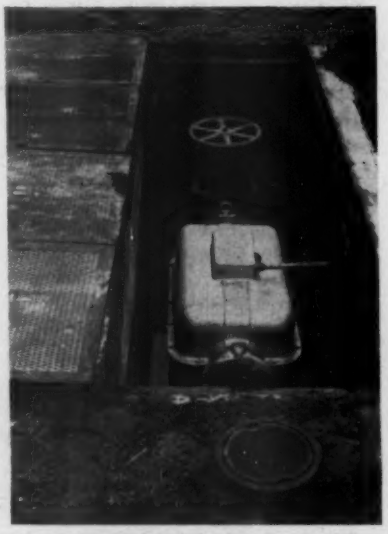
Faced with these basic operational difficulties and economic considerations. Borough officials decided to look into the potentialities of a new obstructionless flowmeter then being introduced by Fischer Company, Warminster, Pa. Known as the Magnetic Flowmeter, this unit operates as an a-c generator in which the flowing fluid is the armature. Electrodes are mutually perpendicular to the externally generated fluid and the direction of flow. The voltage induced is directly proportional to the rate of flow.

The magnetic meter proved ideal for the purpose. It has no constrictions, and is unaffected by changes in density, viscosity, or consistency. Moreover, it has no permanent pressure loss chargeable to the meter (any loss shown is equivalent to that of a similar length of straight pipe). The sewage influent moves through the meter just as it does through the 6" pipe that carries it from Westville to the primary sediment tanks. As the flow is measured, the "Mag" meter transmits the reading to a secondary recorder at the Gloucester City Treatment Plant 100 feet away.

How accurate are the readings? The magnetic flowmeter records and totals the sewage flow within an accuracy of ±1%.

Now in operation over a year, the unit has effectively answered this tough and unusual sewage metering problem. It can handle flows from a fraction of a gallon per minute to many millions of gallons per day.

Thus, neighborly cooperation and the effective use of advanced technology have proved beneficial to two New Jersey communities. Gloucester City is being adequately reimbursed for the use of "future" facilities which would normally lay idle, while Westville has found that Magnetic Flowmetering determines their sewage bill with extreme accuracy.



THIS 6-INCH F&P Magnetic Flowmeter at the Gloucester plant measures the raw sewage influent from Westville, N. J.

Photo above shows how easy it is to apply the Christy contour gasket around an ALOXITE porous plate . . . forming tight joints between plates, as in insert.

Contour gasket forms positive seal between ALOXITE® plates—without cement

A new, simplified method of installation adds a further "plus" to the many advantages of ALOXITE aluminum oxide plates for rapid filter bottom construction. The method utilizes a synthetic contour gasket, easily fitted around each plate. A bead in the gasket insures tight joints continuously.

By eliminating jointing with cement or asphaltic compounds, installation time is greatly reduced. Effective sealing no longer depends on care in applying cement or attention to temperature and consistency. Pores cannot be clogged, as sometimes happens, by cement slopping over on the plates. When necessary, individual plates can be readily removed or replaced without breakage or damage to the rest of the bottom.

These contour gaskets are sold for about 50¢ each by Christy Firebrick Company, 506 Olive Street, St. Louis 1, Missouri. They are available from stock.

For information on ALOXITE porous underdrains, write Dept. X-110, Refractories Div., The Carborundum Co., Perth Amboy, N. J.

For time-tested porous media, count on . . .

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Look what you won't need with your next flow controller

NOW THERE'S A MODERN, surprisingly simple way to control flow in your filter effluent piping. The Modulair "P" rate of flow controller, fully pneumatic, installs almost as easily as a piece of pipe, gives you accuracy with less "hardware" and attention than other types of controllers.

SIMPLE! Pre-assembled unit saves you money on initial cost and installation cost. Simplicity of design reduces maintenance almost to zero. All working parts are enclosed. No hydraulic valves or valve operator. No water supply needed. No drive gears or linkage. No complicated piping. No pilot valve. No floor drain.

COMPACT! Has the shortest laying length of any rate-of-flow controller. No appendages. Shown in the picture at the right is one of three Modulair controllers at the modern filter plant in Fairmont, Minnesota. Note the trim, clean installation, with no "spaghetti" of hydraulic piping, no appendages. Unit is simply "a box on a pipe."

USEFUL, FREE BULLETIN. The space saving, low cost and operating economies of the Modulair "P" are fully detailed on the pages of our Bulletin 951. Complete specifications included. Write for a copy—with no obligation on your part.

SIMPLEX
VALVE AND METER COMPANY
a division of PFAUDLER PERMUTIT INC.
Lancaster, Pennsylvania

Equipment News

CONTINUED FROM PAGE 29A

The plants are available in three sizes, 1000, 3000, and 5000 gallons per day. Sewage flows on a per capita per day basis vary depending on the type of installation.

Valve Designed to Improve Filters

1110

Dorr-Oliver, Inc., Stamford, Conn., has developed a new, high-capacity valve design that has been adopted as a standard component for all their drum and disc filters.

The new valve design offers a streamlined flow for filtrate in single and multiple-stage continuous filters. All internal obstructions have been eliminated.

The new valve will be supplied in all single and dual solution applications of Dorr-Oliver continuous filters including Oliver® chemical and metallurgical filters, vacuum precoat filters, string discharge filters, and sludge dewatering filters; and American® Savealls and other disc filters.

Non-Electric Safety Control System

1111

California Controls Co., Oakland, Calif., announces the availability of a non-electric, self-powered engine safety control system that protects all types of engine installations against dangerous overspeed, temperature and pressure conditions.

Operated through a small captive charge of compressed air, the system requires no batteries or other special electrical supplies necessary for most safety control systems presently available. This Calcon control can put into operation almost any type of pilot operated valve, switch, warning or other device when the captive air charge is dumped to atmosphere by sensing units.

The new system is designed on the modular system and standard components are combined to meet the requirements of each type of installation.

Electronic Data Processing for Small Utilities

1112

Remington Rand Univac Division, Sperry Rand Corp., New York, N. Y., has announced the availability of a new computer concept for bringing electronic data processing to small business and utilities. The system, immediately available, is called Univac STEP for "Simple Transition to Electronic Processing."

The new solid-state computer system has been developed for customers now using punched card equipment but who have growing electronic data processing needs.

An exclusive feature of this plan is its flexibility. With the Univac Solid-State computer as a nucleus, the basic system consists of four units which can be easily expanded to greater capacity when growth of business demands it.

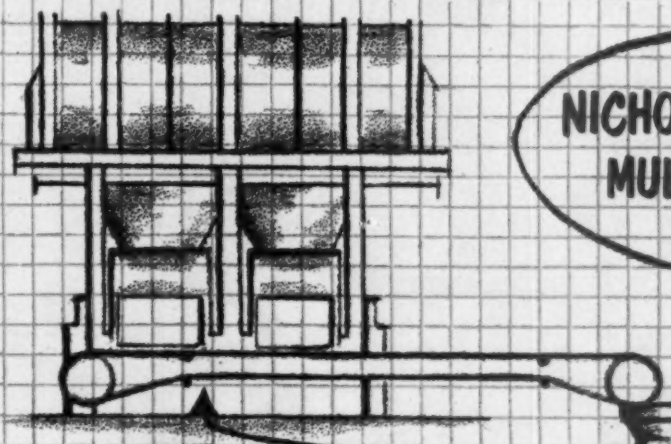
CONTINUED ON PAGE 94A

NICHOLS ENGINEERING & RESEARCH CORP.
80 PINE STREET, NEW YORK 5, N. Y.

PROJECT COMPLETE AND ULTIMATE SLUDGE DISPOSAL DATE

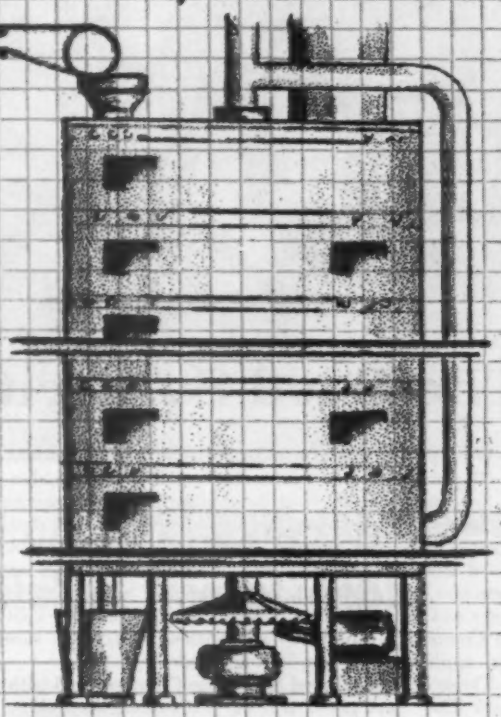
PAGE OF PAGES

COMPUTED BY CHECKED BY APPROVED BY



NERCO-EDCO "ROTO-PLUG" SLUDGE CONCENTRATOR

NICHOLS HERRESHOFF MULTIPLE HEARTH FURNACE



1. No Chemicals
2. Low Power
3. Low Maintenance
4. Rugged

-ECONOMICAL-
SIMPLE - CLEAN - SAFE

Write for Bulletins 238 and RP 100

NICHOLS Engineering & Research Corp.
80 Pine Street, New York 5, New York
3513 N. Hovey Street, Indianapolis 18, Ind. • 405 Montgomery Street, San Francisco, Calif.

Equipment News

CONTINUED FROM PAGE 92A

The STEP plan is intended to be a relatively inexpensive introduction to computer processing and brings it within reach of small and medium-sized businesses. Yet, the plan is sophisticated. The system can simultaneously read four cards, punch a fifth, print out data and solve arithmetic problems.

The four units which comprise Univac STEP are: a central processor with a 26,000 digit capacity; s high-speed reader handling 450 punched cards per minute, a punch unit handling 150 cards per minute, and the high speed printer.

The system can be expanded by adding up to four additional memory units, each of which will carry 6,000 more digits, making possible an ultimate capacity of 50,000 digits which equals that of the standard Univac Solid-State computer.

The Good Samaritan

We lay no claim to exclusive virtue, nor any patent rights on high moral principles. But we humbly endorse the "Golden Rule" because we have seen the effects of its application to our own business.

Years ago as a struggling new foundry, M & H designed and made a better valve and hydrant. Then, and many times since then, we received most valuable help and encouragement from water works men, engineers and public officials. From the beginning, service-to-the-customer was an M & H watchword. But the reverse—customer-service to the Company—voluntarily and without obligation, surely was a practical application of the "Golden Rule."

These customer "good Samaritans" have stayed with us through the years. They have given us many a lift along the road down which has come today's product. Engineering and foundry research has proved many of their suggestions worthy of adoption—thus helping us to design and manufacture the world's best valve and hydrant.

This customer good-will has been, and is, a human and inspiring phase of M & H steady growth into a position of leadership in the water works industry.

(No. 6 of a Series)

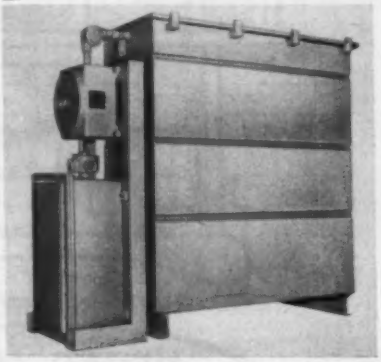
M&H VALVE AND FITTINGS COMPANY
ANNISTON, ALABAMA
SUBSIDIARY OF WALWORTH

Automatic Potential Control For Cathodic Protection

1113

Electro Rust-Proofing Corp., Belleville, N. J., has introduced an improvement on existing cathodic protection methods. Called "Automatic Potential Control", it brings automation to cathodic protection against corrosion.

Since the rate of corrosion of underground or submerged structures is affected by deterioration of coatings, temperature and environmental



changes, deposition of salts, biological growths, etc., adjustments are necessary in the current applied.

Now, automatic potential control makes these adjustments automatically. It provides a continuous indication of the protective state of the structure, regulation of the applied current, retarding of coating deterioration, conservation of power and anode material, and prevents overloading of the d-c rectifier. Visual and audio alarms provide additional safeguards against malfunction in the system.

The new system can be applied to such installations as pipelines, intake screens, chemical processing equipment, and condenser water boxes, and it can be adapted to existing cathodic protection systems as well as new ones. Each system is individually designed and installed, and may be adapted to all climatic or environmental conditions. Corrosion control surveys are conducted anywhere by experienced corrosion engineers.

Variable Speed Control for Centrifugal Pump and Fan Drive

1114

U. S. Electrical Motors Inc., Los Angeles, Calif., announces the development of a new controlled speed sys-

CONTINUED ON PAGE 96A

Newport News rack rakes . . . minimum-manpower way to keep water intakes free of debris

Newport News mechanical rack rakes are power-operated rakes for cleaning trash racks at water intakes, including those at hydro-electric plants, steam plants, pumping stations, and similar installations throughout this country and abroad. Under ordinary conditions, one man per shift keeps racks clean for a dozen bays.

Operate in channel guides for maximum cleaning action

A Newport News rake *won't ride over trash* nor will its teeth drop the debris, because the rake operates in channel guides for positive action. Special teeth are available for cleaning racks of filamentous algae, seaweed, etc.

The Newport News mechanical rack rake has been built to operate in bays from 5 feet 6 inches wide to 28 feet 6 inches in width. Forebay design determines the maximum width for a single rake. In the case of a very wide bay, intermediate guides are sometimes used to reduce the length of the rake. There are many typical installation arrangements to fit your needs. Newport News engineers are prepared to individualize these designs for you.

If you have a debris problem, write for a copy of THE NEWPORT NEWS MECHANICAL RACK RAKE, an illustrated booklet describing the installation, operation, and advantages of a Newport News rake.

Engineers . . . Desirable positions available at Newport News for Designers and Engineers in many categories. Address inquiries to Employment Manager.

Newport News
Shipbuilding and Dry Dock Company
Newport News, Virginia

Equipment News

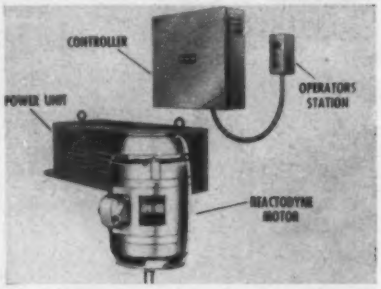
CONTINUED FROM PAGE 94A

tem for centrifugal pump and fan drives, which provides variable speeds from all-electric induction motors. In most applications, the control system, designated Reactodyne, will be used where it is desirable to automatically control the pump and/or fan speeds. In such applications, the control of speeds is accomplished by means of a signal from a small potentiometer which can be actuated by liquid level, temperatures or pressure.

The drive system is designed for use on "cubic" loads (such as heat exchanger fans and sewage pumps) where torque requirements fall off rapidly at lower speeds. Use is not intended on constant torque loads. This all-electric variable speed drive is designed to operate from a standard 220/440 volt, 60 cycle A.C. power supply. Drive motors are available in a wide choice of horizontal or vertical types in the open design.

No moving parts are contained in the design of the control stepless, speed changes are made by means of an electrical dial control, and the operator's station can be set remotely from the drive.

In an emergency where continuous operation is mandatory, the entire control system may be by-passed and



the motor operated at maximum speed by connecting directly to the plant's A.C. supply line.

Ratings are available from 1 to 30 horsepower with a 2:1 speed variation, which is adequate for most pump and fan applications. When required, higher speed ratios can be obtained.

control

for algae and aquatic weeds

In small amounts, Triangle Brand Copper Sulfate controls algae growth and kills some of the more troublesome aquatic weeds. They disintegrate where they are, which prevents downstream infestation or clogged waterways.

In sewage pipes, Triangle Brand Copper Sulfate can be used in such low concentrations to control root and fungus growth that surface trees remain unaffected.

Two informational booklets, "The Use of Copper Sulfate in the Control of Microscopic Organisms," and "Copper Sulfate for Root and Fungus Control in Sanitary Sewers and Storm Drains," available on request.

Phelps Dodge Refining Corp.
300 PARK AVENUE, NEW YORK 22, N. Y.

Sheeting Material for Lab Sinks and Table Tops

1115

Johns-Manville Corp., New York, N. Y., offers a full description of colorlith, widely used for laboratory table tops, sinks, hoods, shelves, and other hard-working surfaces, in a brochure recently published. A monolithic asbestos-cement sheeting, Colorlith is highly resistant to physical and chemical abuse, yet provides a dense homogeneous surface in three attractive colors, charcoal gray, cameo brown, and surf green.

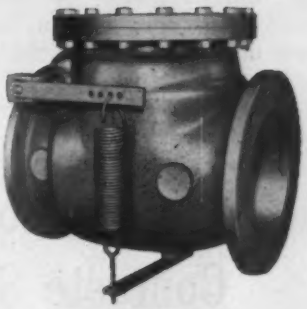
The brochure describes the available thicknesses of this material, with recommendations of optimum thickness for certain applications. In addition, the bulletin contains recommended procedures for fabricating, bonding, and cementing, as well as suggestions for proper maintenance of the applied surfacing.

Tabular data are included giving physical properties of the ¼, ¾, and 1¼ inch thicknesses, such as density, tensile strength, screw-holding strength, and both Brinell and Rockwell hardness. A table of chemical resistance properties covers exposure to standard laboratory concentrations of common reagents such as concentrated and dilute hydrochloric, sulphuric, and nitric acids, ether, Toluene, and carbon tetrachloride.

EDDY New Improved Products Meet Modern Needs

EDDY Fire Hydrant

- **Improved, streamlined, modernized**
- **Optional break-flange**
- **Large diameter barrel**
- **New self-sealing main valve packing**
- **Requires no lubrication**
- **Opens *with* pressure**
- **Closes *against* pressure**
- **Underwriters' listed**
- **Standardized, interchangeable parts**

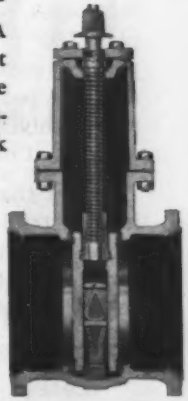


EDDY Check Valves

Completely new designs of horizontal swing check valves are available in sizes from 4 through 12 inches. They operate dependably in either vertical or horizontal positions and incorporate construction features which provide unusual flexibility of operation. These valves may be converted in the field from plain to single- or double-lever operation to meet changing requirements. Other check valves up to 24 inches.

EDDY Gate Valves

In addition to the regular line of EDDY Taper Seat AWWA gate valves, EDDY now offers a newly designed parallel seat AWWA gate valve in sizes through 12 inches. This valve has been specifically engineered to provide long, trouble-free service. Working parts are designed with heavy, thick section and large seating surfaces for dependable operation and improved wearing qualities. The valve has two-point, free-floating wedging for minimum friction and maximum operating ease. Other AWWA gate valves are available through 48 inches.



Whatever your waterworks requirements, it will pay you to have full information on the complete EDDY *line of valves and hydrants.*

EDDY VALVE COMPANY
A Subsidiary of James B. Clow & Sons, Inc.
WATERFORD NEW YORK

News of Suppliers

Clow to Build Australian Plant

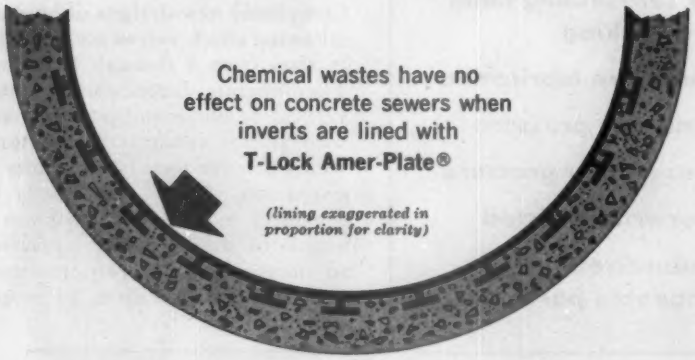
The Board of Directors of James B. Clow & Sons, Inc., have approved the construction of a 3 million dollar cast iron pressure pipe plant in Melbourne, Australia.

In making the announcement, the company disclosed that it is joining forces with General Industries, Ltd., a 50-year-old Australian company, in joint and equal ownership. The new company will be known as Metters-Clow Pty., Limited.

General Industries presently manufactures cast iron soil pipe, plumbing fixtures, gas and electrical ranges, radios and television sets.

Plans for the new plant are well under way and construction is expected to start within 30 days, and production in late 1961. The plant will be located within 15 miles of downtown Melbourne and will employ 1000 people.

How to Protect Concrete Sewers from Chemical Wastes


Chemical wastes have no effect on concrete sewers when inverts are lined with
T-Lock Amer-Plate®
(lining exaggerated in proportion for clarity)

T-Lock Amer-Plate is a high polymer PVC sheet, easily cast into pipes, tunnels and structures to form a partial or complete 360° protective lining. Used in inverts, it permanently protects concrete from corrosive chemical effluents. In arch areas, it positively stops oxidized H_2S corrosion. T-Lock is also highly abrasion resistant; impartial tests show that it abrades at only 1/70th the rate of concrete.

The fact that T-Lock ends erosion and corrosion problems in industrial and municipal sewer systems is attested to by more than five million square feet now in use. Write for complete data on this maintenance-saving lining before designing your next sewer.

Applicators strategically located throughout U. S. and Canada

Amercoat® CORPORATION

Dept. WK • 4809 Firestone Boulevard • South Gate, California

921 Pitner Ave., Evanston, Ill. 309 Carnegie Ave., Kenilworth, N. J. 2404 Dunels St., Jacksonville, Fla. 6550 Supply Row, Houston, Tex. 111 Colgate, Buffalo, N. Y.

Permutit Sends Purifiers to Chilean Disaster Areas

Permutit Co., Division of Pfaudler Permutit, Inc., disclosed that it has sent six of its "packaged" water purification plants, each entirely self-contained and gasoline powered for use under emergency conditions, to Valparaiso, Chile. The units will be used in areas still without clean drinking water as a result of the disastrous earthquake which swept that country early this summer.

The purifiers were assembled at the company's Lancaster, Pa., plant at the request of UNICEF, the United Nations' relief agency. Each unit has a treating capacity of 25 gpm and can be mounted on a truck for quick transportation.

In many areas hard hit by the earthquake, disruption of water lines created a shortage of purified water with a consequent serious threat to health.

The purifiers weigh four tons each and each is mounted on a rigid platform. Included in the "package" are a settling tank, chlorinator, filters, and chemical feeders. To put a unit into operation, it is only necessary to connect it to the source of unpurified water and start the engine.

Dickey's Birmingham-Bessemer Plant Completed

W. S. Dickey Clay Mfg. Co., Birmingham, Ala., has announced that its ultra-modern $5 million Birmingham-Bessemer plant has been completed, and that full production is expected to be reached soon. All new equipment, including one of the world's largest tunnel kilns, has been installed in the new facility.

The 820-foot, two unit plant located some fifteen miles southwest of Birmingham, Ala., will have an initial rated capacity of 55,000 tons a year. A complete line of vitrified clay pipe in 4 through 36 inch diameters and related clay products will be produced when the entire plant is in operation.

Ground was broken in 1959 for the first section of the new facility at Bessemer. A second unit was started after fire destroyed the Dickey Birmingham plant last November. The general sales offices and a sales distribution yard, however, remain at the same location in Birmingham where

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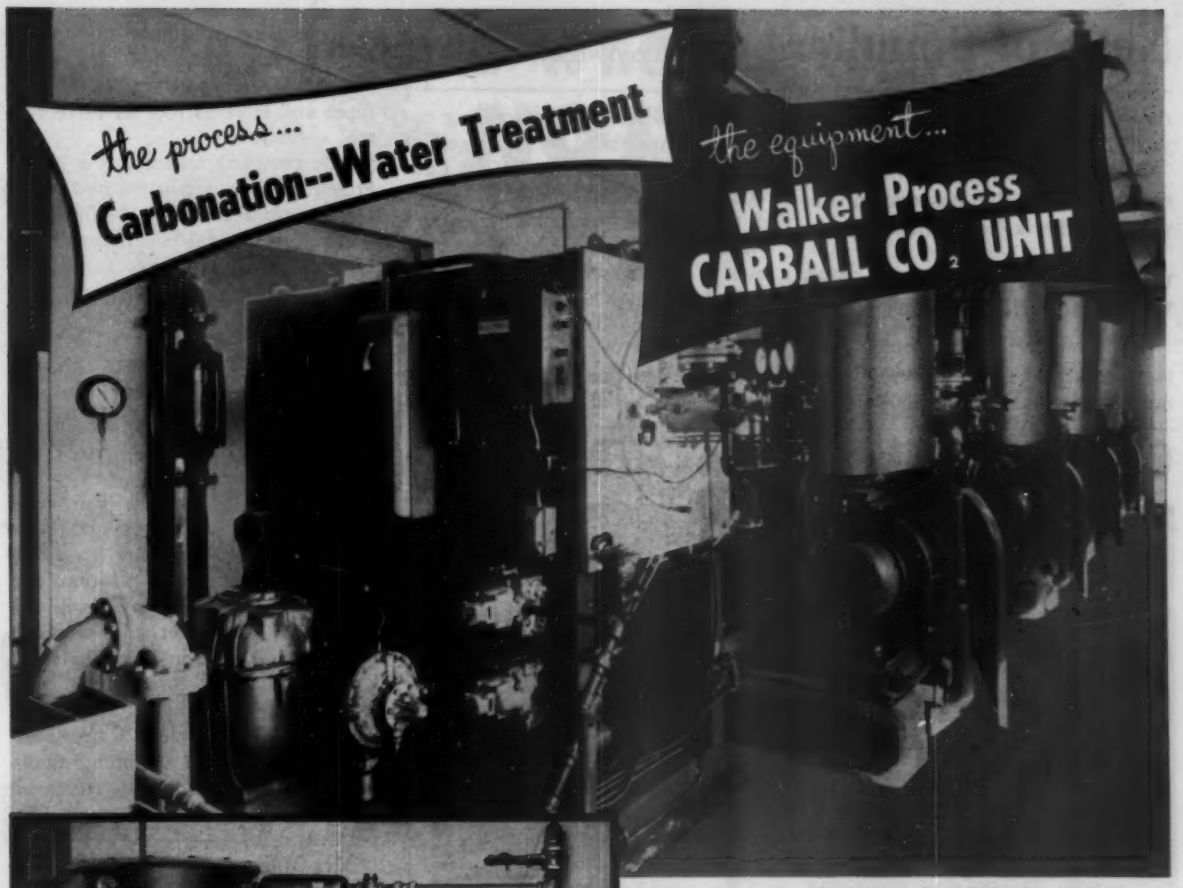
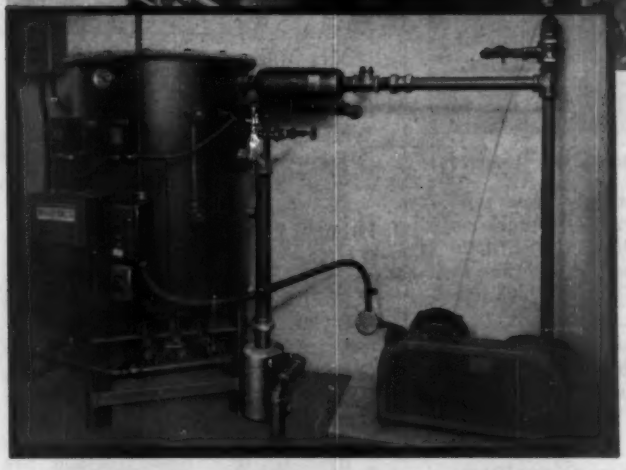




Four size 4 Carballs at Kansas City, Mo. burn either gas or oil to produce max. of 40,000 lbs. CO_2/day. Size "O" unit at left produces 570 lbs. CO_2/day for Jefferson, Iowa Water Plant.

CARBALL
CO_2 UNIT

Walker Process now offers carbonation units for all lime softening plants from the very small to the largest. Sizes range from the new "OO" unit with minimum capacity of 55 lbs. CO_2/day to the No. 4 at maximum output of 10,000 lbs. CO_2/day.

Engineers can readily provide an entire carbonation system by simply specifying the appropriate size CARBALL in combination with Walker Process SPARJER diffusers . . . . . assuring

50% More CO_2
Clean, Tasteless Gas
100% Combustion
Unique Absorption Method
Economical Operation
Factory Tested Package System

Write for bulletins 7W83 - 7W85 and 7W88

WALKER PROCESS

WALKER PROCESS EQUIPMENT INC.
FACTORY • ENGINEERING OFFICES • LABORATORIES
AURORA, ILLINOIS

News of Suppliers

CONTINUED FROM PAGE 98A

they have been for more than thirty years.

The completion of the new plant coincides with the observation this year of Dickey's 75th anniversary.

Willamette Creates Valve Division

Willamette Iron and Steel Company, Portland, Oregon, recently announced that it has assigned divisional status to its valve manufacturing operations. Appointed as Manager of the new Valve Division is Casi Cadrecha, Jr., who will be in direct charge of all activities including sales and engineering. Responsible for over-all sales of valves and valve equipment is Earl H. Atkinson, Sales Manager.

Although Willamette has for a number of years custom-manufactured and sub-contracted water and sewage works valve equipment, the new Division continues on an expanded basis production of a standardized line of valves of various types and sizes as well as valve control systems.

The company anticipates a steady growth pattern within the new Valve Division to accompany the organization's already established situation in the field of water works and hydroelectric equipment manufacture.

OMAHA *chose* STEEL PIPE *for* FEEDER MAIN

. . . every length was hydrostatically tested in the shop to AWWA standards!

Maximum length and minimum wall thickness, as only steel pipe provides, enabled the Metropolitan Utilities District of Omaha to install a big pipe line through a quiet residential district with little inconvenience. Only 180 ft. of narrow trench was open at one time to install the coal tar enamel coated 48 in. diameter, ⅝ in. wall thickness steel pipe in. 40 ft. lengths.

Workers of the Metropolitan Utilities District, under the direction of General Superintendent Kenneth Young, are shown lowering a section of pipe into place in the trench just a few feet behind the digger.

STRENGTH
TIGHTNESS
ELASTICITY
ECONOMY
LONG LIFE

. . . these are inherent qualities of fabricated *steel* pipe. Compare *steel* pipe with other types . . . you'll see why "wherever water flows, steel pipes it best." You can always specify *steel* pipe with confidence.

For your copy of the latest steel pipe brochure, write—

STEEL PLATE FABRICATORS ASSOCIATION
105 West Madison Street • Chicago 2, Illinois

Magner Appointed By Fischer & Porter Co.

Jerry M. Magner has been appointed Sales Manager of the Water & Waste Division of the Fischer & Porter Co., Warminster, Pa. In his new position, Mr. Magner will direct sales activities in the Division's three major markets, which include water treatment equipment for swimming pools, municipal water and waste treatment systems, and industrial waste disposal systems.

Mr. Magner was previously District Manager of the Baltimore Office. Before this, he specialized in Water & Waste sales in the Baltimore Office.

Hagan Chemicals Appoints Kleber

John P. Kleber has been appointed manager of the newly-organized Water Chemical Sales Division of Hagan Chemicals & Controls, Inc., Pittsburgh Pa. In his new position he will be responsible for coordinating sales of boiler water, municipal and cooling water chemicals.

Prior to his appointment, Mr. Kleber has been manager of the firm's Municipal and Process Waters Department since 1949. He became affiliated with Hagen in this department in 1940.

A native of Dallas, Texas, Mr. Kleber served with that city's water Department before joining Hagen. He is a registered professional engineer in the state of Pennsylvania. He is a member of the American Water Works Association, the American Chemical Society, and the National Association of Corrosion Engineers.

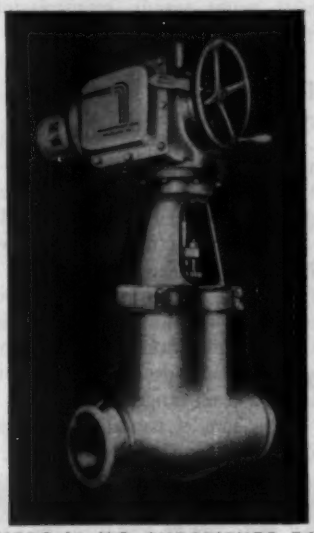
Ever figure what it costs ***NOT*** to use

LimiTorque® *Automatic* VALVE OPERATION?

How much does opening and closing Valves *by hand* cost you—in man-hours—in physical danger to workmen who must climb to high or dangerous locations?

How much time, labor, and money could be saved in your plant by opening and closing valves *automatically*—at correct operating speeds—by the mere "push of a button"? With LimiTorque, one finger does the work of many hands. LimiTorque control permits one man to operate, and know the exact position of each valve from a central, conveniently located control panel.

LimiTorque protects valve seats, discs and stems from damage, by automatically shutting-off power source, should an obstruction interfere with valve closing. Valves operated by LimiTorque are always seated tightly, because the seating thrust of valve disc is accurately maintained in each closing-cycle, due to the patented torque limiting mechanism.



LimiTorque is, by far, the most widely used valve operator in the World... Send for complete new Catalog L-550, on your Business Letterhead.

THERE IS NO SUBSTITUTE FOR —

LimiTorque®

PHILADELPHIA GEAR CORPORATION
KING OF PRUSSIA (SUBURBAN PHILADELPHIA), PA.
Offices in all Principal Cities

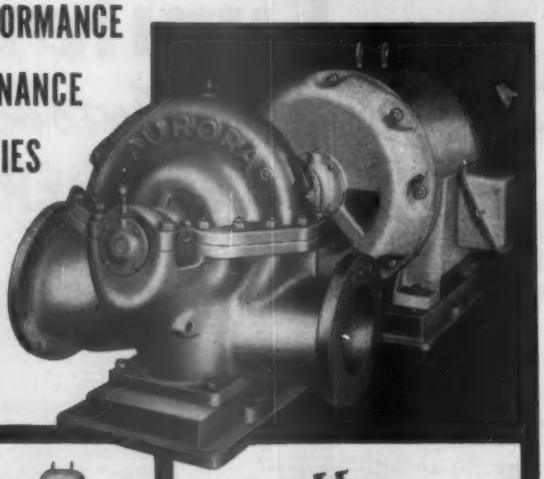
INDUSTRIAL GEARS & SPEED REDUCERS • LIMITORQUE VALVE CONTROLS • FLUID AGITATORS • FLEXIBLE COUPLINGS
Limitorque Corporation • King of Prussia, Penna.

AURORA® Split Case

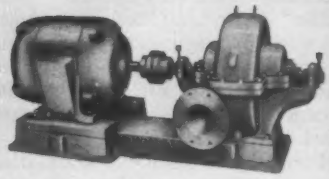
CENTRIFUGAL PUMPS

with

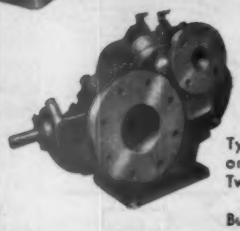
• SMOOTH PERFORMANCE
• EASY MAINTENANCE
• HIGH CAPACITIES



Type OJ Horizontally Split Single Stage Double Suction. Bulletin 105-B.



Type AJ Horizontally Split Two Stage Opposed Suction. Bulletin 106-B.



Type AJ Diagonally Split Two Stage

Bulletin 106-DS

• Capacities to 6000 GPM—heads to 600 feet—continuous operation.

• Both suction and discharge on bottom half of case . . . piping or motor-pump alignment never disturbed . . . lugs on top half of case for easy removal . . . by-pass in lantern ring exposed in lower half of case . . . fast, easy to inspect, clean and maintain . . . lines are back in operation fast!

• Streamlined liquid flow . . . hydraulically and dynamically balanced impellers . . . perfect alignment with in-line boring with top half of case in position . . . large standardized shaft sizes for maximum strength . . . short bearing centers for maximum rigidity and balance . . . low NPSH . . . smooth, long-term top performance . . . long life!

IDEAL FOR: Water Service • Boiler Feed • Circulating • Cooling Tower • Pressure Build-Up • Fuel Transfer • Boosting to Pressure or Elevated Tanks • Many General Applications.

FOR COMPLETE INFORMATION WRITE—OR CALL

AURORA Always PUMPS

AURORA PUMP DIVISION
THE NEW YORK AIR BRAKE COMPANY

1020 LOUCKS • AURORA, ILLINOIS

LOCAL DISTRIBUTOR IS LISTED IN THE YELLOW PAGES OF YOUR PHONE BOOK

New Bulletins

Pug Mill Lime Slakers

1116

B-I-F Industries, Inc., has issued a new bulletin that provides the latest information on the company's Pug Mill Type Lime Slakers, designed to provide automatic water radio control at all rates with no attention required by an operator.

The bulletin gives a detailed description of these units as well as the features and data on their operation. Photographs and a schematic drawing illustrate the unit and its construction features.

Steel Pipe

1117

Steel Plate Fabricators Association, Inc., Chicago, Ill., is offering an 8-page journal presenting interesting highlights of the use of steel pipe on several major water line construction projects.

This illustrated bulletin uses a number of construction photographs to show the diversity in use of steel water pipe. The literature is designed to be of interest to anyone concerned with water supply, transmission and distribution.

Liquid Level Controls

1118

Magnetrol, Inc., Chicago, Ill., has made available a new 12-page illustrated booklet that describes the company's displacement-type liquid level controls, for actuating pumps, valves, high and low level alarms or other functions in applications involving agitated, foaming or dirty liquids. Other applications include chemicals, water or sewage handling in wide or narrow level ranges.

The booklet contains technical and design operating advantages, full model and component descriptions, and installation dimensions.

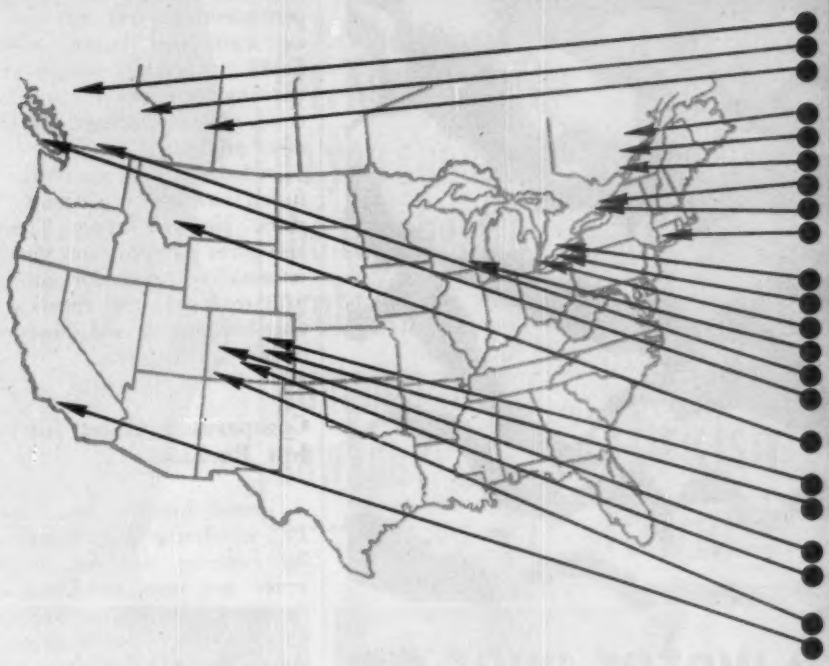
Non-Corrosive Drainline Catalog

1119

American Vulcathene Division, Nalge Co., Inc., Rochester, N. Y., has published its new 20-page en-

CONTINUED ON PAGE 104A

microstraining INSTALLATIONS FROM COAST TO COAST



- INUVIK, TOWN SITE
- FORT ST. JOHN
- CALGARY POWER CO., CAMBROSE
- TERREBONNE
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- BROCKVILLE
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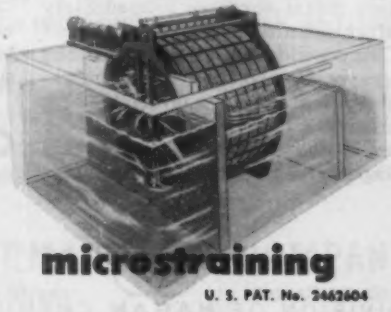
- DENVER BOARD OF WATER COMMISSIONERS
- ESTES PARK
- COLORADO CENTRAL POWER CO., EVERGREEN
- PALISADES
- SAN GABRIEL VALLEY WATER CO., FONTANA

Microstraining as an economical aid in producing better water for more people is becoming widely accepted by water supply engineers.

Since 1956 over 20 installations have been put in operation or are now under construction, treating a total flow of more than 120 mgd.

For details of the process and installations in the U. S. write:

Glenfield & Kennedy, Inc.
275 Halstead Avenue
Harrison, New York
Telephone Tennyson 5-2552



why pump water over mountains like these ?

The "mountains" are tubercles—from the inside of a water main—enlarged only slightly. Mountains like this are what send pumping costs skyrocketing—and reduce the effective diameter of mains and piping as much as 20%.

Tuberculation forms fast . . . in fact, it starts the moment a main is cleaned, and gets in its worst licks during the first few months after cleaning. So it makes sense to protect metal surfaces immediately after cleaning—by using Calgon® Composition TG right behind the scraper. Composition TG is remarkably fast at forming a protective film, putting a barrier between the bare metal and water. It will also help disperse the removed corrosion products, making it easier to flush them from the main.

Calgon Composition TG has other benefits, too, when used in continuous treatment. (1) It makes "red water" complaints a thing of the past. (2) It is especially helpful in areas of low flow, and when temperatures go up. (3) Its greater efficiency keeps chemical costs down.

A letter or phone call will bring you more information on how Calgon can help. Or, an experienced Calgon engineer will be glad to make detailed recommendations on your specific problem.

CALGON COMPANY
HAGAN CENTER, PITTSBURGH 30, PA.

DIVISION OF HAGAN CHEMICALS & CONTROLS, INC.

New Bulletins

CONTINUED FROM PAGE 102A

gineering and parts catalog which describes "Vulcathene", a complete, permanent acid and corrosion resistant waste and drainage system of plastic plumbing equipment. The catalog descriptions cover sinks, traps, pipe and fittings, adapters and other products.

Included is a section on the "Polyfusion" method of joining "Vulcathene" pipe and fittings. The catalog also gives technical and dimensional information, installation notes, tables of thread sizes and chemical resistance information, and shows pictures of each drainline item.

Comparator Chart for Ion Exchange

1120

General Ionics Corp., Pittsburgh, Pa., is offering a combination price list covering standard and special water and resin tests and an ion exchange resin comparator chart. The price list describes the standard and special tests available from the company covering many of the fundamental phases to be considered in prescribing water conditioning and treatment equipment.

The Comparator Chart shows comparable grades of standard ion exchange resins available from the different producers, listing the resins by chemical form, trade name, and manufacturer.

"Priceless Water"—Now, A Complete Program

1121

Johns-Manville Corp., New York, N. Y.—Just a year ago, Johns-Manville announced the availablity of its 84-page book "Priceless Water" to the Water Utility Industry. The reception given this book since then has been gratifying.

The response received was most interesting—and a revelation also. It disclosed a need for us to implement "Priceless Water" with communications aids aimed at the man in the

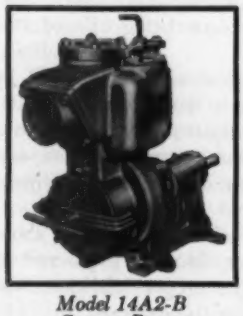
CONTINUED ON PAGE 106A

End Plate off

Towel out

End Plate on

"Towels can jam the works, but good!" says Cecil Kent, owner, Sanitation Service Company, Jacksonville, Florida, "I've had 'em clog conventional pumps so bad, it meant a shutdown from two hours to two days.



Model 14A2-B Sewage Pump

"That's why I've standardized on Gorman-Rupp sewage pumps. And what a difference! Fewer shutdowns . . . clogging cleared in just three to fifteen minutes! This cuts average maintenance costs from $120 to only $12 per pump per year. On my 21 Gorman-Rupp pump installations, that adds up to a whopping big saving. Over $2200 a year on parts, packing, materials, and labor.

"Sure, I had a problem—but *no more!*"

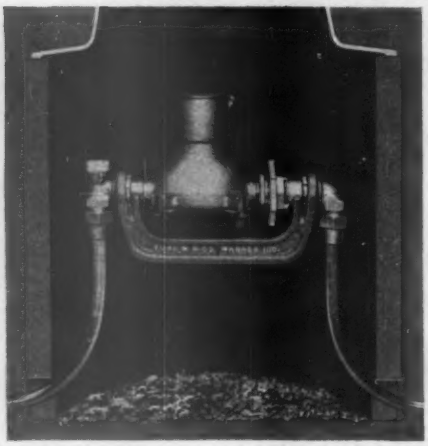
Thrifty, trouble-free, self-priming Gorman-Rupp sewage pumps —2", 3", 4" or 6" sizes—can be connected to your power or ordered complete with power units. Write for complete specifications.

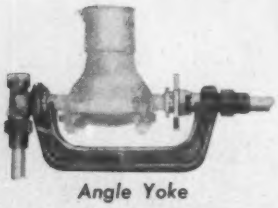
THE GORMAN-RUPP COMPANY

305 Bowman Street **Mansfield, Ohio**

Gorman-Rupp of Canada, Ltd., St. Thomas, Ontario

Meter Settings "Stay Put" with Ford Yokes





Angle Yoke

Straight Yoke

Riser Yoke with compression valve at each end, outlet valve inverted for basement setting.

Connections to inlet and outlet piping just can't get out of alignment with Ford Yoke settings. Prevent leaks and other difficulties which frequently result from physically disconnecting or disturbing service lines during meter changes. A simple twist of the expansion connection handwheel is all it takes to install or change a water meter in a Ford Yoke setting.

The result: Any meter needing testing or repairing gets immediate attention instead of being left until real trouble develops.

You'll appreciate the savings in time and increases in revenue that accompany a Ford Yoke setting. Over a million are in use.

Write for complete information on models available for every condition.

FORD for *better* water services

THE FORD METER BOX COMPANY, INC., Wabash, Indiana

VALVE OPERATION

DEAN TRUCK MOUNTED VALVE OPERATOR

MAKES EVERY VALVE POWER OPERATED

PAYNE DEAN & CO. CLINTON, CONN.

New Bulletins

CONTINUED FROM PAGE 101A

street to furnish community leaders through the water works official, a complete program to jar public indifference, marshal popular support and enlist civic-minded citizens in water advancement plans and projects. This has been done. The result is a kit including booklets, window posters, newspaper advertisement, radio and TV scripts—all slanted to the consumer to create a wider awareness of water problems.

A 4-page folder illustrates and describes the numerous items the kit contains. As was the case with the "Priceless Water" book, every item of the kit is designed to make you, the water works man, guide the efforts of your community to improve water service.

TV Pipe Inspection

1122

National Power Rodding Corp., Chicago, Ill., announces that water pipe and sewer inspection by closed-circuit TV can cut maintenance costs by as much as 95%. It is possible to sit in comfort in a mobile viewing room and see the inside of every foot of a pipe system, even those with pipes as small as 4" diameter.

A new folder describes how this contract service works.

Tech. Book on Pump Motors

1123

U. S. Electrical Motors Inc., Los Angeles and Milford, Conn., announces that a new brochure, consisting of a collection of technical articles on pump motors, reprinted from its "Underground Raindrops" magazine, is now being offered free on request.

The technical articles, written by the company's engineering department, are illustrated with various charts, diagrams, graphs, tables, and cutaways dealing with the subjects covered.

"What You Should Know about Turbine Pump Motor," explains how the use of the proper lubricant type and frequency is reflected in: (1)

Continuous operation, (2) Low maintenance costs, (3) Low power consumption, and (4) Low lubrication costs. Test results, and lubricant recommendations are presented.

"Facts about Pump Motor Bearings," details the effect of contact angle on the life of angular contact thrust bearings.

"The Why and How of Pump Motor Protection" describes and evaluates the various kinds of protective devices used to prevent electrical and/or mechanical damage: disconnect switches, thermal relays, fuses, lightning arrestors, and others.

"Pumping Stations and Sound Control" explains, with illustrations, the various ways of eliminating pumping noise, according to the needs of different types of location.

"Helpful Steps in Submersible Installations" gives time-saving and trouble-saving procedures for installing submersible pump motors.

Rotary Distributors

1124

Walker Process Equipment Inc., Aurora, Ill., describes its Rotary Distributors in a new bulletin recently released. Design details are given on their Mast type units, featuring mechanical seals which eliminate the need for mercury hydraulic seal; and the new Walker Process Turntable Type ball bearing base unit is presented for the larger diameter filter beds.

The bulletin contains design data on rotary distributor selection, dosing chambers, recirculation and filter construction; and includes a number of photographs of typical installations.

Transite Underdrain Pipe

1125

Johns-Manville Corp., New York, N. Y., has issued a 4-page folder that describes the use of Transite Underdrain Pipe in subsurface drainage systems for highways, airports, flood control projects, plant sites, and similar projects.

The bulletin contains photographs showing how Transite perforated asbestos-cement pipe is installed and assembled utilizing its unique plastic coupling. In addition, drawings illustrate how modern subsurface drainage practice has been followed in determining hole sizes, distance between holes, and method of perfora-

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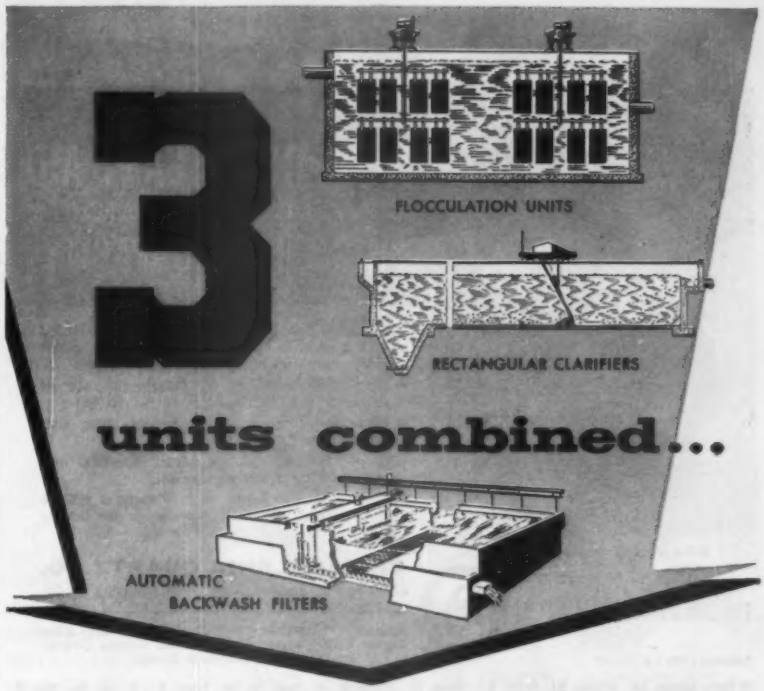
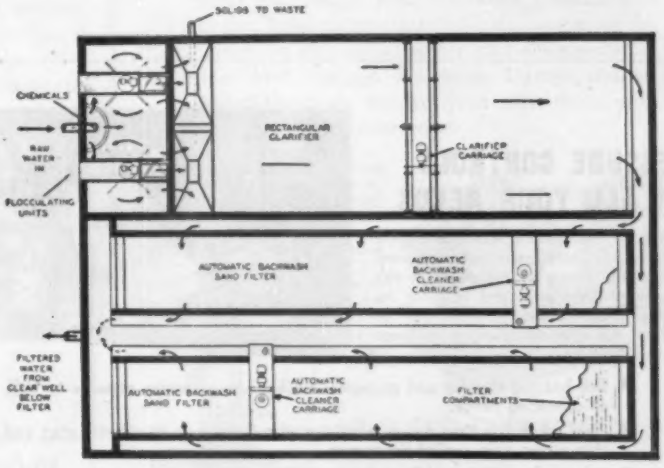


...for COMPLETE WATER TREATMENT



in Modular Construction

For municipal and industrial water supplies, the Hardinge equipped water treatment plant is available in unit sizes of from 1 M.G.D. to 5 M.G.D. Flocculation, clarification, and filtration equipment—combined in modular units and sized to your requirements for a continuous supply of high-quality water. Can be furnished complete with automatic plant controls.

Write for full details.

HARDINGE

COMPANY, INCORPORATED

Main Office and Works • 240 Arch St., York, Pa.

"Hardinge Equipment—Built Better to Last Longer."

NEW YORK
TORONTO
CHICAGO
HIBBING
SALT LAKE CITY
SAN FRANCISCO
HOUSTON
LAKELAND
BIRMINGHAM

WITH
N-Sol COAGULANT AID
LOW, LOW TURBIDITY
HIGH, HIGH CAPACITY

Big, heavy floc formed with N-Sol (activated silica) enmeshes suspended solids. Floc settles rapidly removing more impurities. Results . . .

- Decreased turbidity at maximum rate of capacity; e.g., figures cut by ⅓ to ½.
- Increased filter capacity; longer runs, e.g., from 16 to 32 hours.

Can N-Sol help your problem? Samples and directions for jar test on request.

Prepared in your plant with N sodium silicate and a reacting chemical. No charge for license under our N-Sol Process Patents.

N-Sol produces sparkling, clear water

PHILADELPHIA QUARTZ CO.
1166 Public Ledger Bldg., Philadelphia 6, Pa.

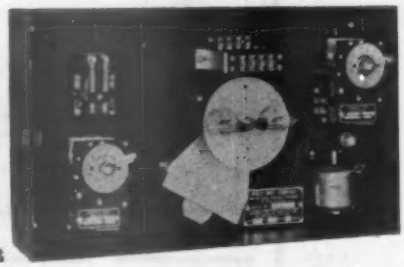
PQ SOLUBLE SILICATES

Associates: Philadelphia Quartz Co. of Calif. Berkeley & Los Angeles, Calif.; Tacoma, Wash.; National Silicates Limited, Toronto & Valleyfield, Canada

Trademarks Reg. U.S. Pat. Off.

PQ Plants: Anderson, Ind.; Baltimore, Md.; Buffalo, N.Y.; Chester, Pa.; Jeffersonville, Ind.; Kansas City, Kan.; Rahway, N.J.; St. Louis, Mo.; Utica, Ill.

PRESSURE CONTROLS
FOR ALL YOUR NEEDS



Healy-Ruff Company offers a complete line of easy-to-install, simple-to-use pressure-sensing controls for water works and sewage fields. Control only, or indicating and recording as well, can be supplied. All systems incorporate these desirable features:

- Ball bearing rotation and springless mechanism—measures pressure to ½% of operating range.
- Field adjustable time delays, provided where necessary to prevent start and stop surges from cycling the pumps
- Independent high and low pressure adjustments
- Minimum differential between start and stop points

THE R-4 ROTOTROL permits controlling high and low elevation of water in an elevated tank, stand pipe, or reservoir. Automatically compensates for pumping friction. Closed system and booster system controls also available. *Bulletin R-4*

THE PW ROTOTROL controls both pressure and water level in hydropneumatic tanks. Cuts off pumps on either high pressure or high level. Air-add or air-release types. *Bulletin PW-6*

THE RPS ROTOTROL controls level in pumping stations, sewage plants or reservoirs. Senses level change through corresponding change of pressure in compression bell submerged in wet well. Purged air or compression pipe types. *Bulletins RPS and RS3*

HEALY-RUFF COMPANY
783 Hampden Avenue • St. Paul 14, Minn.

First in dependable controls for waterworks and sewage—since 1929

Remote supervisory controls • Complete system controls • Elevated tank controls • Sump controls • Hydropneumatic tank controls • Float controls • Alternators • Alarm silencers • Protective devices

New Bulletins

CONTINUED FROM PAGE 107A

tion for the various sizes of Transite Underdrain Pipe. The sizes include 6, 8, 10, and 12 inch diameters. Lengths are 10′ and 13′. The minimum crushing strengths (ASTM 3-edge bearing method) are also shown.

Automatically Controlled Bar Screen Cleaning

1126

Minneapolis-Honeywell Regulator Co., Philadelphia, Pa., has published a new Instrumentation Data Sheet that explains the various control systems used to clean bar screens automatically with the differential method. Schematic drawings supplement the printed text to give the reader a clear explanation of the three Honeywell control systems using the differential method.

Pictures of automatic controls on bar screens, or bar screens equipped with automatic control, show the application data needed to understand more clearly the operation of the various systems. A "Guide Specification" also provides the consulting or municipal engineer the information necessary to prepare bidding specifications on automatically controlled bar screens.

Ion Exchange Developments

1127

Nalco Chemical Co., Chicago, Ill., describes the recent developments that have led to a better understanding of using ion exchange as a water treatment process in a reprint of an article prepared by engineers of the company.

This 7-page reprint contains the answers to many of the more common questions raised by users of ion exchange processes. It is illustrated with graphs and photographs.

Gratings and Treads

1128

Dravo Corp., Neville Island, Pittsburgh, Pa., recently published a 12-page bulletin that explains the characteristics of a new type of steel industrial grating and the facilities for its manufacture and fabrication.

This bulletin, entitled "Tru-Weld

Grating and Stair Treads," cites the company's 30 years experience as a national distributor of grating and stair treads and outlines the features of its automated plant which went into production early this year.

Design, panel widths and load tables for Tru-Weld grating and stair treads with both standard and close spacing are detailed, as are typical clearances and the various types of fasteners used for installation. Included also are necessary specifications for ordering.

The bulletin lists such applications for the grating and stair treads as trench drainage systems, machinery floors, conveyor systems, operating floors, power plants, operative machinery, tank walkways and stairs, river locks and dams, sewer systems, and sinter and pelletizing plants.

Anhydrous Ferric Chloride

1129

Pennsalt Chemicals Corp., Philadelphia, Pa., has prepared a 12-page leaflet which attempts to collate the outstanding facts from various sources and to offer a concise and accurate manual on the properties, uses, and methods of handling ferric chloride that may be of interest to engineers, superintendents, and operators.

Believing that the recommendation of special process is the function of the chemist and engineer, no effort has been made to include them, but rather, the publication's intent is solely to provide useful information about specific products manufactured by the Company.

The publication includes charts and diagrams that illusrtate the main features of the text material.

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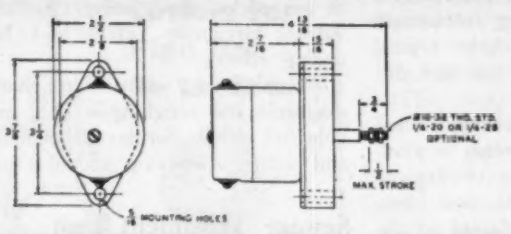
D. C. SOLENOIDS



Synchro-Start **SL SERIES SOLENOIDS**

are for operating engine throttles, fuel pump racks, chokes, etc. and are available with several variations. Other models in 1" and 1½" strokes.

VOLTAGES (D. C. Only)
6V. 12V. 24V. 32V.

CURRENT DRAW (Pulling)
55A. 35A. 15A. 12A.

CURRENT DRAW (Holding)
1.6A. .8A. .4A. .3A.

DUTY
Continuous

CYCLES
Not to exceed 6 per minute

PULL
Approximately 10 lbs. over ½" stroke

WEIGHT
2¼ pounds

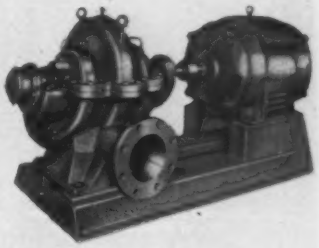
SYNCHRO-START PRODUCTS, INC.
8151 N. RIDGEWAY AVENUE • SKOKIE, ILL.

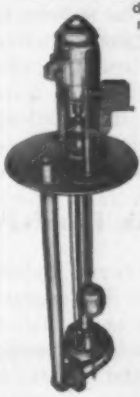
for faithful, efficient public service...

PUT WEINMAN ON THE PAYROLL

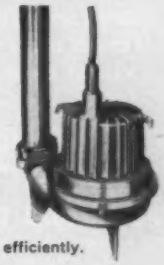
More and more, city engineers recognize the real economy of dependable Weinman Pumps for low-cost, trouble-free handling of drainage, water and sewage. With Weinman, revenue goes further towards meeting the ever-increasing demands on municipal water and sewage facilities. And, rugged Weinman Pumps deliver 'round-the-clock service year after year with only routine maintenance.

For instance, city officials rely on Weinman Type L, Single Stage, Double Suction, Split Case Pumps to move water in volume; for high, medium, and low head pumping to 4000 GPM; for 24-hour-a-day service with no down time. Split case design makes routine maintenance fast and easy.





. . . and, to handle drainage pumping from low to higher level, they look to Weinman's line of Vertical, Submerged, Non-clog Sewage Ejectors. These proven municipal workhorses pump raw sewage and other waste materials without clogging.

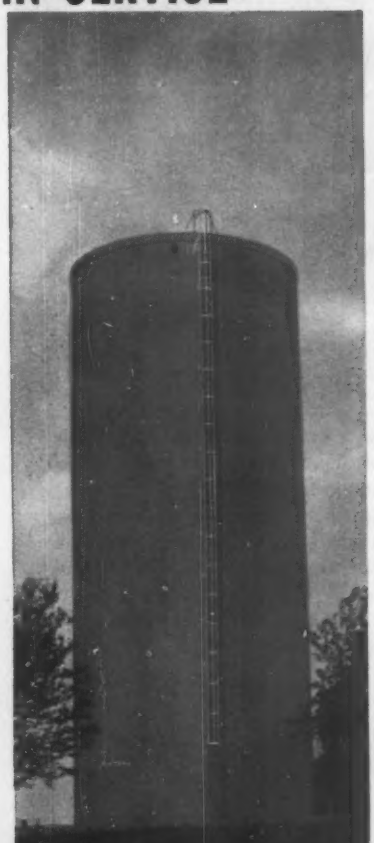


. . . or, for permanent or portable sump installations, the Weinman Type M Non-clog, Immersible Pump handles sewage, industrial wastes and drainage water swiftly and efficiently.

So, for a ready solution to growing water problems, consult your Weinman Specialist. He's listed in the Yellow Pages. Or, write direct for descriptive literature.

THE WEINMAN PUMP MFG. CO.
210 SPRUCE STREET COLUMBUS 15, OHIO
CENTRIFUGAL SPECIALISTS

MORE THAN 2000 PRESTRESSED CONCRETE TANKS IN SERVICE



New 660,000 Gallon Stand Pipe, City of Wadsworth, Ohio

Consider these features
- Minimum maintenance
- 75% construction cost spent locally
- Owners seldom return to other types
- Longest service life of any tank
- Lowest overall cost to community

Send for Bulletin T-22

PRELOAD

THE PRELOAD COMPANY, INC.
355 Lexington Ave., New York 17, N. Y.
Tel.: MUrray Hill 7-0488
351 Jefferson, Dallas, Texas
Tel.: WHitehall 1-5707

PRELOAD CONCRETE STRUCTURES INC.
837 Old Country Road
Westbury, L. I., N. Y.
Tel.: EDgewood 3-4040

THE CANADA GUNITE COMPANY, LTD.
125 Hymus Boulevard
Pte Claire, P. Q., Can.
Tel.: OXford 6-67-

HERRICK IRON WORKS
28400 Clawiter Road, Hayward, Calif.
Tel.: LUcerne 1-4451

New Bulletins

CONTINUED FROM PAGE 109A

Vitrified Clay Pipe

1130

National Clay Pipe Manufacturers, Inc., Washington, D. C., has prepared a new 6-page brochure on clay pipe, its specifications and applications. Titled "Lifetime Vitrified Clay Pipe," it is designed for use by professionals, as well as a general informative reference, and lists identification numbers for Clay Products in ASTM, ASA, U.S. Government, and AASHO specifications. It describes basic clay products, typical characteristics and uses of vitrified clay pipe, and the latest factory-made joints, designed to give better control over infiltration, exfiltration and root penetration.

The history of clay processing through modern manufacturing methods is briefly detailed, together with NCPMI's research program in jointing techniques, load characteristics, performance characteristics of all sanitary piping and quality standards.

Automatic Sampler

1131

Hardinge Co., Inc., York, Pa., has issued a revised 8-page catalog describing its re-designed automatic sampler. The literature describes in detail the new operating mechanism of the sampler and includes typical arrangements for both wet and dry processes.

This sampler takes periodic "cuts" (or samples) from a stream of moving material, either wet or dry, at any stage in a continuous flow process. It is particularly adapted to the mining, stone products, ceramics, chemical and allied process industries.

Leak Proof Pump Packing

1132

Newage Industries, Inc., Jenkintown, Pa., announces the availability of a new detailed catalog sheet explaining "Lonsor", the metallic packing and its uses.

This is virtually a permanent plastic packing compound. A minimal quantity added occasionally maintains a dry gland for months. It is designed to be extremely effective in centrifugal pumps.

The plastic metallic packing comes in one-pound wrapped cakes, and is easily broken off and stuffed into a box, gland or shaft by hand. It is pliable, and conforms to rods, shafts and bearings, making a perfect lubricating surface. "Lonsor's" high lead and antimony content allows its self-lubricating properties to form a frictionless running surface, and because of its pliability, "Lonsor" compensates for inequalities which may exist in worn or out-of-round shafts.

The leak-proof packing material is acid free, and its lead base renders it impervious to acids with which it may come in contact. It is made for use in valves, stuffing boxes, pistons, cylinders, valve stems, centrifugal or rotary pumps, hydraulic presses and steam winches.

Bronze Valve Catalog

1133

American Valve Mfg. Co., Manhasset, L. I., N. Y., has published a new, comprehensive 8-page catalog, covering the company's complete line of bronze valves. The items include screw end or sweat end gate valves with "O" ring or conventional packing, renewable disc or standard brass seat screw end globe valves, screw end or copper-to-copper compression stops and valves, and a wide variety of gas cocks, check valves, radiator valves, circulator valves and balancing elbows.

Accompanying dimension charts, diagrams and roughing-in data provide full details for layout planning and fixture specifying and ordering.

Sewage Treatment Unit

1134

Eimco Corp., Salt Lake City, Utah, explains how its new Oxigritter primary sewage treatment units accomplish grit removal, pre-aeration and clarification in a double compartment circular tank.

The bulletin tells how sewage enters an inner compartment where aeration separates grit from organics ahead of clarification and also pre-aerates the sewage flow. Grit separations of 65 to 200 mesh can be made in the areation compartment, before organics pass through peripheral discharge ports to the clarification compartment for primary sedimentation.

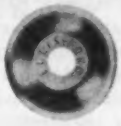
Photographs and other illustrations are included in the literature.

For the latest and most complete design data on peripheral feed clarifiers for liquid waste treatment

WRITE FOR LAKESIDE SPIRAFLO BULLETIN 126

LAKESIDE
ENGINEERING CORPORATION
222 West Adams St. Chicago 6, Illinois

Ellis Heavy Duty Pipe Cutters For Pipe Up To 16" Dia.



With Long Lasting Cutter Wheels

Designed for water works men who appreciate the rugged construction of drop-forged frame and links; and a tool that assures no pipe breakage, no re-cutting and no spoilage.

THREE SIZES
No. 01 for 4" to 8" Pipe
No. 1 for 4" to 12" Pipe
No. 1B for 4" to 16" Pipe

write today for free literature

ELLIS & FORD MFG. CO.
1100 COOLIDGE RD.
BIRMINGHAM, MICH.

Vitrified Pipe with "O" Ring Joints

1135

Evans Pipe Co., Uhrichsville, Ohio, has announced the recent publication of a 4-page bulletin that describes the company's Wedge-Lock, Type "O" ring joint line of vitrified pipe.

Included in the bulletin are installation procedures, dimensions and specifications. Pictures and other illustrations show how the joint is effected and a cutaway drawing shows how the joint looks before and after it has been sealed.

Flow Device for Clarifiers

1136

Chain Belt Co., Milwaukee, Wis., has released a 12-page bulletin that describes its Verti-Flo, a device designed to hold turbidities to a minimum and to control inlet distribution, vertical and weir velocities of settling tanks.

The bulletin provides photographs of the unit and its operating features. Also included are operational diagrams, cutaway drawings and on-the-job pictures. The unit may be used on either sewage treatment or industrial waste systems.

Laboratory Furniture

1137

Kewaunee Technical Furniture Co., Statesville, N. C., has just released a new, 142-page Metal Scientific Laboratory Equipment Catalog.

This comprehensive book covers the company's complete line of industrial metal laboratory furniture, laboratory fume hoods and plumbing and electrical fixtures. In addition to the basic units and furniture assemblies shown, several pages are devoted to how laboratory assemblies are built up, laboratory work tops and metal furniture construction details.

Sludge Density Control

1138

Ohmart Corporation, Cincinnati, Ohio—How the density of sludge in sewage treatment plants is automatically controlled, with consequent major cost savings is described in newly issued Ohmart bulletin. The system employs a gamma radiation source and the company's patented cell which converts gamma radiation directly into electrical energy for density measurement and control.

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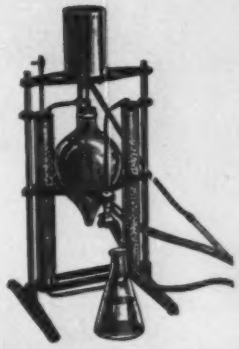

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P. O. Box 2V Richmond 5, Va.

New Bulletins

CONTINUED FROM PAGE 111A

Small-Flow Sewage Treatment

1139

Dorr-Oliver Inc., Stamford, Conn., has available a completely revised 8-page brochure which describes the CompleTreator®, a unique unit providing complete sewage treatment in a single tank, using modern, mechanized sanitary engineering methods for the disposal of domestic waste of 150 persons (15,000 gpd) or less, or the population equivalent.

The unit's operational design is illustrated by a diagram and flow-sheet; photographs show on-the-job applications.

Pumping and Hydraulic Data

1140

Peerless Pump Hydrodynamics Div., Food Machinery and Chemical Corp., Los Angeles, Calif.—Cost of electrical pumping—how to survey a deep well—methods for testing pumps—these are but a few of the helpful facts contained in a newly issued 20-page manual titled "Useful Pumping and Hydraulic Engineering Data.

Written with strong emphasis on practical data for the engineers' every-day use, this manual has many useful charts and problem solving formulae. For example, there are facts on how to figure NPSH, Pump Efficiency, Mechanical and Electrical Equivalents, and a Pipe Friction Loss Chart. Also included are many other informative reference items including a Weir Table, Orifice Charts of pipe and Friction Loss Charts.

Primary Treatment Plant

1141

Yeomans Brothers Co., Melrose Park, Ill., is offering a complete technical presentation of the Spirahoff® sewage treatment plant which is contained in a single structure.

This 8-page catalog is unusually complete and will be extremely helpful to those who are interested in compact plants. Design data includes detailed engineering drawings with all dimensions, volumes, and surface areas. Operation characteristics plus comprehensive technical specifications are also included. A cutaway view of the two-story Spirahoff with its settling compartment and digestion chamber shows the entire operating cycle in easy-to-understand fashion.

Package Sewage Treatment Plants

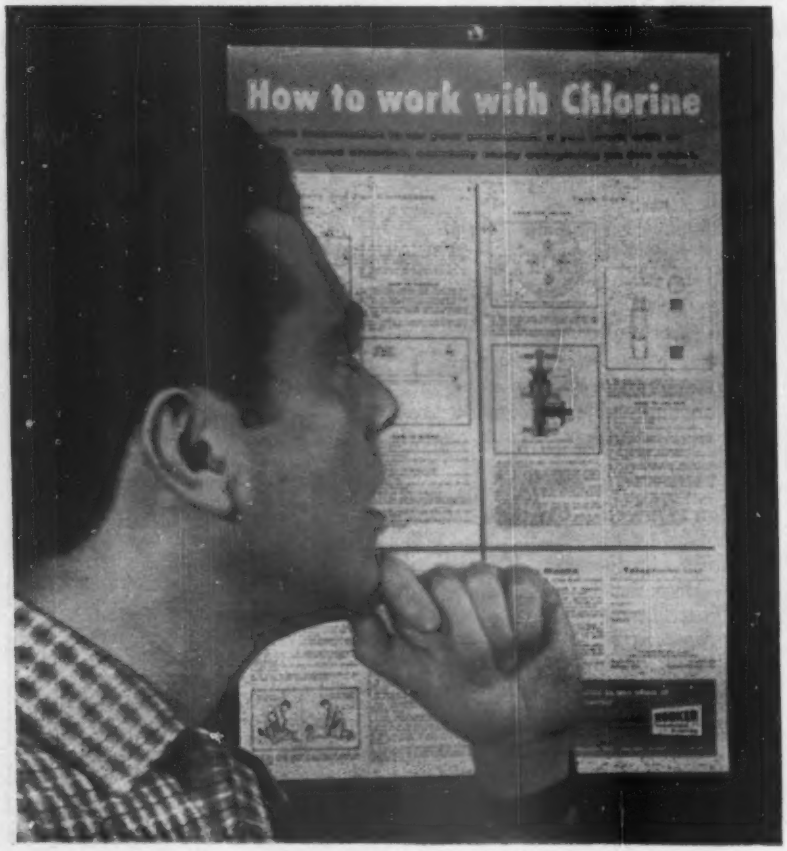
1142

Walker Process Equipment, Inc., Aurora, Ill., has published a 12-page bulletin describing its Sparjair package sewage treatment plants that utilize the contact stabilization process. The plants are especially designed for installations where space requirements are a major consideration.

Electric Check Valves

1143

Golden-Anderson Valve Specialty Co., Pittsburgh, Pa., has released a new 8-page bulletin that describes the company's electric, double-cushioned, check valve used basically on pump installations.



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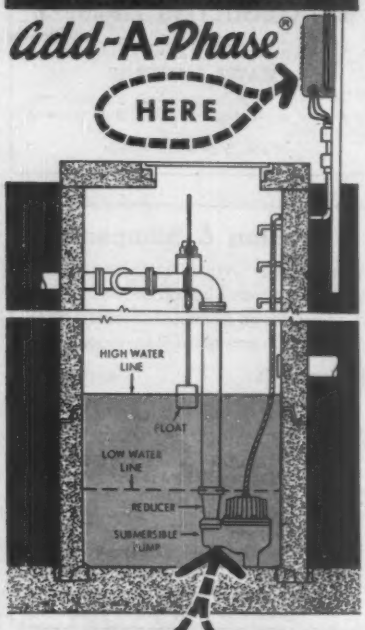

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WATER & SEWAGE WORKS
185 NORTH WABASH AVENUE
CHICAGO 1, ILLINOIS

No Postage Stamp Necessary If Mailed in the United States

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WATER & SEWAGE WORKS
185 NORTH WABASH AVENUE
CHICAGO 1, ILLINOIS

READER SERVICE CARD

for

WATER & SEWAGE WORKS

JUST

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AND

MAIL—

TO

RECEIVE

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LITERATURE

AND

CATALOGS

LISTED

IN

THIS

ISSUE

WATER & SEWAGE WORKS

"from Chicago" **An available① means for increasing digester performance**

Accelerated

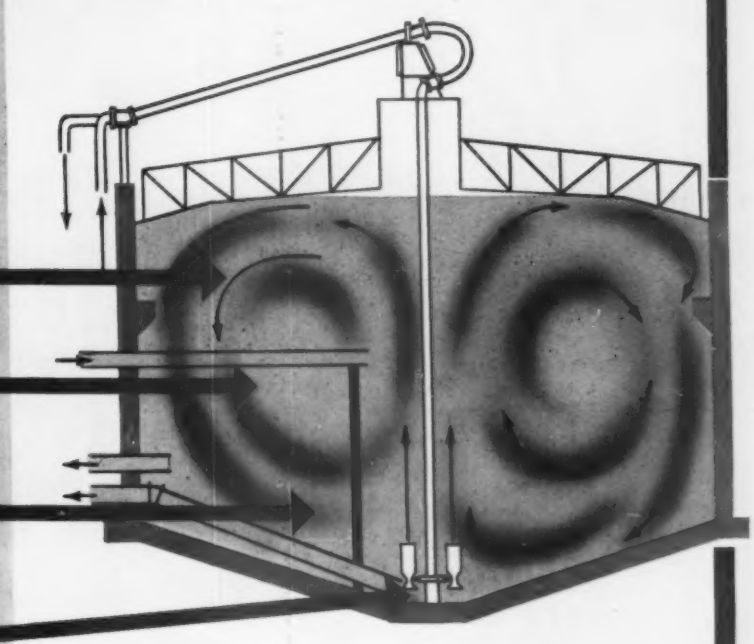
CRP

Sludge Digestion System

*Trademark

by insuring Homogeneous Sludge through

CONTINUOUS MIXING



Scum free due to outward radial flow at surface

Greatest loading capacity for accelerated digestion

Continuous Tank Homogeneity and thorough mixing

Highest mixing capacity . . . bottom diffusion with clog-proof GasFusers② assures total tank mixing

CONTINUOUS CONTINUOUS CONTINUOUS CONTINUOUS CONTINUOUS

①*License under U. S. Patent No. 2777815 available through Consulting Engineer specification.*

②*"GasFuser" Continuous Gas Recirculator*

55 operating and specified installations of the CRP* System with "Chicago" gas mixing equipment since 1955 prove its unparalleled acceptance…serving cities from 2000 to 250,000 population.

Putting Ideas to Work

FOOD MACHINERY AND CHEMICAL CORPORATION
HYDRODYNAMICS DIVISION

CHICAGO PUMP

622-H DIVERSEY PARKWAY • CHICAGO 14, ILLINOIS

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POSITIVE CONTROL OF MATERIALS IN MOTION BIF METERS FEEDERS CONTROLS

CUT FEEDING TIME... PREVENT RUNAWAY DOSAGES!

Alum
Carbon
Soda Ash (Light)
Soda Ash (Dense)
Sodium Fluoride (Light)
Sodium Fluoride (Dense)
Sodium Silicofluoride

Totally-enclosed feeders promote good housekeeping, increase efficiency!

BIF Omega

Feeder Combines Pinpoint Accuracy, Ease of Operation . . . Adapts to Remote or Automatic Control!

Feed powdered, granular or lump material at insured accuracies within ± 1% by weight over widest range . . . easily, conveniently, under dust-free operating conditions. Totally-enclosed Model 30 Loss-in-Weight feeder looks modern, *is modern!* Non-flood feeding mechanism prevents runaway dosages. Sentinel alarms prevent feed deviations. Time-saving design eliminates need for calibration, timing, or catching samples to determine feed rate. No special training of operator required.

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METERS • FEEDERS • CONTROLS / CONTINUOUS PROCESS ENGINEERING

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